LONDON SHOW REVIEW 1950

AUTOMOBILE ENGINEER

ANNUAL EXTRA NUMBER

Vol. 40 No. 534. NOVEMBER 30, 1950 PRICE : 2s. 6d.

AUTOMOBILE ENGINEER

Design, Materials, Production Methods, and Works Equipment

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Publishers : ILIFFE & SONS LTD., DORSET HOUSE, STAMFORD STREET, LONDON, S.E.1
Telegrams : Sliderule, Sedist, London **Telephone : Waterloo 3333 (60 lines)**

COVENTRY :	BIRMINGHAM, 2	MANCHESTER, 3 :	GLASGOW, C.2
8–10, CORPORATION ST.	KING EDWARD HOUSE, NEW ST.	260, DEANSGATE	26B, RENFIELD ST.
Telegrams : Autocar, Coventry	*Telegrams :* Autopress, Birmingham	*Telegrams :* Iliffe, Manchester	*Telegrams :* Iliffe, Glasgow
Telephone : Coventry 5210	*Telephone :* Midland 7191-7	*Telephone :* Blackfriars 4412	*Telephone :* Central 4857

PUBLISHED MONTHLY—SECOND THURSDAY

Annual Subscription : Home and Overseas £1 17s. 6d., including the Special Number ; U.S.A. and Canada $6.00

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The London Show

THE 1950 Show proved to hold more of interest in actuality than in anticipation, and there was in fact a great deal of detail work to appeal to the designer. As usual, the general public also, seemed to find that cars, even if unobtainable, still held an irresistible attraction. The focal point in this connection was the Jaguar stand, where the Mark VII saloon, as a new model, overshadowed even the XK 120. Technically also, the Mark VII must rank as an outstanding vehicle ; the price and specification alone would ensure this. Additionally, it is perhaps the most striking looking production car so far emanating from this country.

Another high light was the introduction of entirely new cars by the Ford Company. These cars constitute a complete break with customary Ford technical practice and appearance and present a modern yet restrained treatment that should serve for a number of years. Interest centred also on the new Triumph Roadster. Based as before on the well tried Vanguard components, it is of excellent appearance, has a number of special features, and embodies the De Normanville overdrive. Two Continental makers, Fiat and Lancia, also exhibited models not hitherto seen in this country, both of them worthy of the designers' close attention, although differing widely in conception.

American Cars

Regarding the American vehicles, interest probably centres on the new Studebaker, the latest maker to adopt the V-eight engine layout now well on the way towards a predominant position in the U.S.A. This car also embodies still another variant of the automatic transmission which may now be regarded as fully established in the American market. Although perhaps of no great significance in present conditions when the import of American cars is prohibited, it may be noted that in many cases where an automatic transmission is an optional fitting, it was the conventional synchromesh transmission that was actually shown at the Exhibition.

Regarding engine design in general, the trend towards larger bores and shorter strokes is well sustained, and in fact two of the entirely new engines shown had bores of substantially greater dimension than their strokes. Although in the case of British designs this tendency probably springs from a desire to keep piston speeds within reasonable limits while extending the speed range, in the case of the American car it would appear to be a necessity, primarily arising from dimensional restrictions on width when the V-eight layout is employed.

Push rod valve actuation is still the most generally employed method, and with modern sound isolation schemes, little is heard within the body of the clatter inseparable from push rods. There is nevertheless still too much noise, although rapid wear has to a large degree been overcome by better design and material. Those makers who have turned over to dual overhead camshaft however, are not likely for various reasons to regret the change, where full advantage has been taken of modern knowledge in design and materials.

Interesting though the Lancia V-six may be technically, the reason underlying the layout is not immediately apparent. Balance is not quite so good as in the in-line arrangement, since there are primary and secondary unbalanced couples, although this is doubtless of little consequence in practice. If the objective is to shorten the engine, it might be fairly argued that the fullest advantage does not seem to have been taken of the fact. Within the dimensions of the body layout adopted, there is evidently room for an in-line engine.

Carburation Systems

Carburation and induction systems present as wide variations as in the past. When so much of engine design has been developed beyond an art into something approaching an exact science, it is the more surprising that induction systems evidence such wide divergences. It might well be questioned whether any real progress is being made in this matter.

In contrast with the striking transmission developments on American cars, British transmission systems have evidenced no great changes for some considerable time. Further, there are yet no signs that there is any intention of offering transmissions giving ease of control comparable with the most advanced American systems. It is however realised that the whole subject, particularly in its relation to export trade, presents one of the major problems that must sooner or later be faced. It is satisfactory to note that an overdrive with simple and positive control is now an optional extra on a popular car. The merits of this

type of control will probably find widespread appreciation, and it might well be extended to the other ratios.

Among detail points of note are the hydraulic operation of the clutch on the new Ford and the renewed interest in ball thrust bearings. Here, there may be the inception of a new approach to clutch actuation. The customary arrangement of carbon block and linkage is apt to develop excessive slack under the almost continuous operation that is imposed by modern traffic conditions. A scheme that embodies a measure of automatic adjustment is needed nowadays by town drivers. While there are no signs that the fashion for steering column control of the synchromesh gearbox has yet run its course, it is satisfactory to note that on the distinctly sports performance Jaguar Mark VII, a short and stiff lever is retained. While on the subject of gear changing, a feature of the Lancia gearbox that should be definitely advantageous is the fact that all synchronising cones are on the driving shaft. Thus for all gears the synchronising mechanism has the same mechanical advantage, so that the change into second gear particularly, should be facilitated.

Little alteration is evident in rear axle design, hypoid bevel gears maintaining a predominant position. Propellor shaft flexibility is evidently undergoing a process of investigation. The advent of two interesting new suspensions, one front and the other rear, would appear to indicate that opinion is still far from stabilized. Further, it is evident that more liberties are being taken with strict geometrical accuracy of front suspension movements, either in the interests of production economy or perhaps location of roll centre. This is noticeable in the Ford front suspension, a layout that deserves close study.

Independent Rear Suspension

Independent rear suspension has so far made only slow progress. At best, the merits of the swing axle or its close derivatives are debatable on cars of any considerable performance, on account of the effect of the high roll centre on handling and the "jacking up" effect under extreme cornering conditions. The Lancia system appears to be an excellent combination of trailing link and swing axle, with the trailing link characteristic predominating. Thus the roll centre is raised, although not to the extent of a true swing axle, while the "jacking" moment is substantially reduced.

There is clearly much that has yet to be learnt on the practical application of independent rear suspension, and in the present state of the art it seems that the half-way state exemplified by the De Dion axle constitutes the best rear suspension so far developed. Unfortunately, the only British example is that on a car designed for more specialized conditions than the general purpose vehicle. It has therefore, suspension characteristics that might not be generally acceptable. Further, it is associated with a front suspension that, while obviously performing a limited duty satisfactorily, falls short of modern requirements in deflection and "feel".

Chassis Lubrication

It is satisfactory to note on one new model a revival of automatic lubrication for spring shackles, steering linkage and suspension. In the past, various schemes have made their appearance over a considerable period, but with notable exceptions few have given complete satisfaction for a variety of reasons. There is however so much to be said for eliminating the hand work in the lubrication of these parts that the Luvax system on the Lanchester will be appreciated by the keen motorist. Such systems were difficult to control and problems of metering at ever varying viscosities to points at various distances proved difficult. Further, the oils then available were not well suited to the conditions. Lubricants then employed were originally intended to deal with fairly even loads at high rubbing velocities, and were not really suitable for non-rotating parts subject to hammer blows of extreme violence under heavy load.

There can however be no question as to the need for automatic lubrication for chassis parts. Not only is it necessary on the score of convenience and maintenance cost to eliminate the hand operation altogether, but more important still, such lubrication is needed continuously while the vehicle is in action. With modern bodywork, the increasing inaccessibility of such grease points is another factor, but most important of all is the need for a continuous flow. At present the driver sets out "all greased up", and with finger light steering, and after 100 miles some of the touch is gone because the grease has been hammered out. As it disappears, the motoring quality of the vehicle deteriorates progressively until the next "grease up". In developing a satisfactory automatic system, it may be necessary to tackle the problems from the other end, namely via the lubricant. Problems of metering and load carrying may prove amenable to the use of low viscosity oils that are nevertheless resistant to hammer blows and seepage.

Heaters still remain something of a problem, it being difficult to devise a really economical system that is fully satisfactory. Noise at the fan and unreliability in the element, as well as mal-distribution of heat within the vehicle, are still faults in many installations.

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ENGINES

Trend to Increased Outputs with Improved Torque Characteristics

AT the last London Show the Ford Company of America showed a new six-cylinder engine of 3.3in. bore and 4.4in. stroke. This year, the Dagenham factory exhibited new models powered by an "over-square" four and six, bore size being 3.125in. over a stroke of 3.0in. The compression ratio is 6.8 : 1, and maximum speed, in the case of the "Consul", being 4,400 r.p.m. with an output of 47 b.h.p.

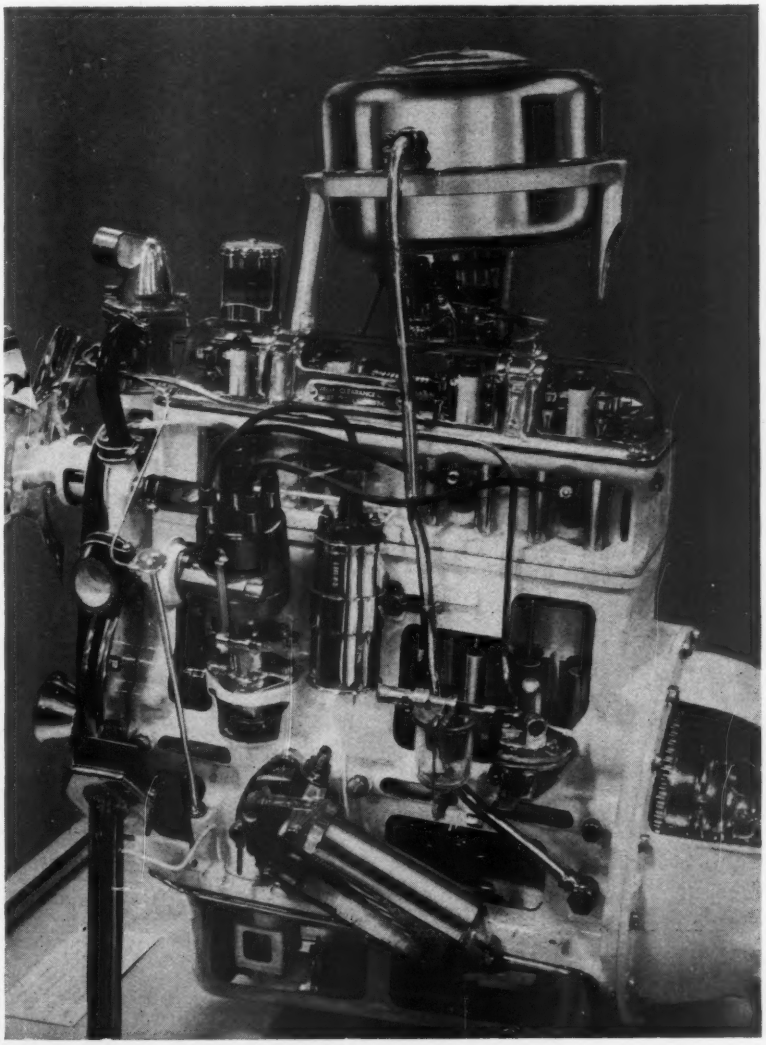
Another new engine form is that on the Studebaker Land Cruiser, this being an "over-square" V-eight of $3\frac{3}{8}$in. bore by $3\frac{1}{4}$in. stroke. It has overhead valves and a compression ratio of 7 :1. With a capacity of 232.6 cu. in. (3.6 litres approximately), the power output is 120 b.h.p. at 4,000 r.p.m. Details are not available, as the car had, in fact, only just been released in the United States. It is interesting to note however, that it replaces a six-cylinder engine of some 200 c.c. greater capacity yet develops 10 more horse-power.

Oldsmobile also show an o.h.v. eight-cylinder V-type engine of $3\frac{3}{4}$in. bore by $3\frac{7}{16}$in. stroke. The capacity is 4,970 c.c. and with a compression ratio of 6.64 : 1 it develops 135 b.h.p. at 3,600 r.p.m.

Fiat, in introducing the new '1400' have taken the over-square layout quite a long way, the four-cylinder engine having an 82 mm. bore, while the stroke has been reduced to 66 mm. This particular engine has a compression ratio of 6.7 to 1 and develops a maximum of 45 b.h.p. at 4,400 r.p.m. It is perhaps surprising that the crankshaft has only three bearings, but they are certainly robust. Such very short crank throws may materially reduce "whip" stresses. A notable feature of this engine is the scoop form of the pressed steel oil sump, there being a pronounced forward sweep which must necessarily pick up a fair volume of air and induce it to flow along the under side of the engine, thereby aiding the dissipation of heat and cooling the lubricant.

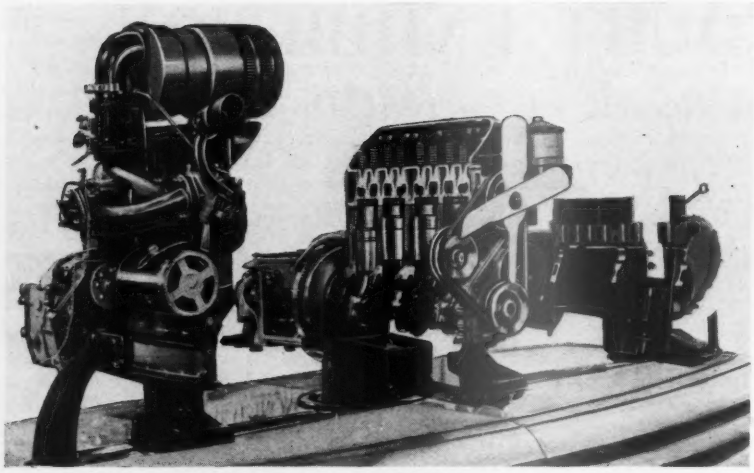
Yet again the tendency to shorten the stroke is evident in the new 3-litre Alvis. This 84mm. bore engine has had the stroke shortened to 90 mm. as against the former practice of 110mm. stroke, and develops its maximum b.h.p. of 83 at 4,000 r.p.m.

As a complete contrast Lanchester show a new 14 h.p. chassis having an engine of approximately two litres capacity, the bore being 76.2mm. with the stroke 107.59mm. The compression ratio is still high, being 6.7 to 1 and the engine develops 60 b.h.p. at 4,200 r.p.m. Though following accepted and well-known Daimler and Lanchester practice, this is an entirely new engine and is a long-stroke four cylinder. It has overhead valves, the crankshaft being carried in three pre-finished type bearings.



Standard Vanguard "Overseas" engine.

To meet the demand for increased performance, the bore of the Humber 'Hawk' engine has been increased from 75mm. to 81mm., the stroke remaining at 110 mm. The capacity has thereby been increased from 1,944 c.c. to 2,267 c.c., i.e. nearly 17 per cent. The output of the smaller bore engine was 56 b.h.p. at 3,800 r.p.m. as against 58 b.h.p. at 3,400 r.p.m. of the revised engine. The torque improvement is



Sectioned model of Fiat 1400 engine.

more important, the yield of the earlier engine being 96.6 lb. ft. at 2,000 r.p.m. with the new version giving 110 lb. ft. at 1,800 r.p.m.

The Sunbeam Talbot "90" has basically the same engine as the Humber "Hawk", but has an overhead valve head, giving a maximum power output of 70 b.h.p. at 4,000 r.p.m. with 113 lb. ft. torque at 2,400 r.p.m.

The Bristol engine has a bore of 66mm. and a stroke of 96 mm., giving a swept volume of 1,971 c.c. There are alternatives to the same basic engine, but the more powerful Type 85C, gives 85 b.h.p. at 4,000 r.p.m. and 106.9 lb. ft. torque at 3,500 r.p.m. The compression ratio is 7.5 to 1 and it is stated that the performance data are based on figures obtained from a series of new engines. When fully run in and free, an increase of up to 8 b.h.p. can be expected. Incidentally, this six-cylinder engine weighs only 350 lb. in the dry condition. A recent detail change is the fitting of hardened dry cylinder liners to increase bore life.

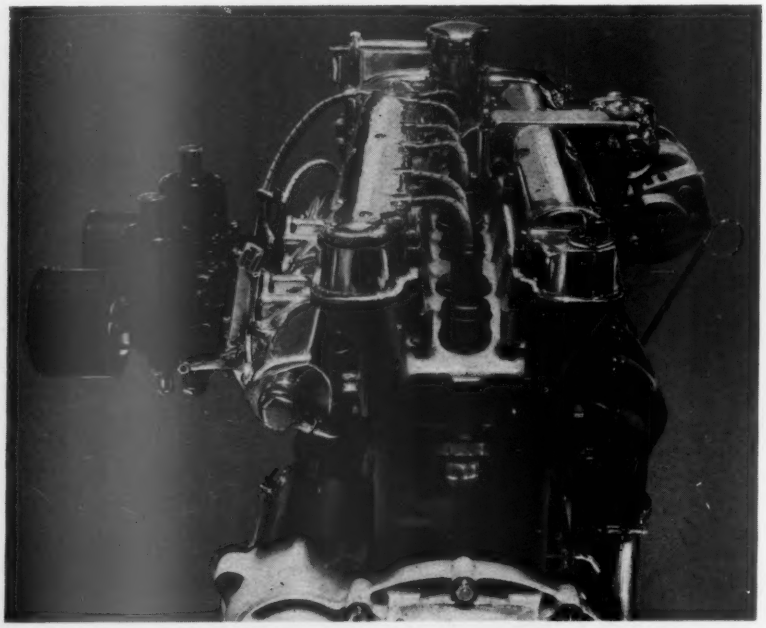
The Aston-Martin and Lagonda chassis employ almost identical engines and, like the Bristol, have overhead valves on either side of the head at a wide angle. The capacity is $2\frac{1}{2}$ litres with 78mm. bore by 90mm. stroke. The compression ratio is 6.5 to 1 with an output of 105 b.h.p. at 5,000 r.p.m.

The Alvis model TA21 engine is a new production and an attractive design. Employing a compression ratio of 7.25 to 1, it is a six-cylinder engine of 84mm. bore by 90mm. stroke, giving 83 b.h.p. at 4,000 r.p.m. and 147 lb. ft. torque at 2,000 r.p.m. The cylinders and crankcase are cast in block, the casting externally being nicely symmetrical. Seven main bearings are employed and the crankcase is internally reinforced at the front and rear mains by a corrugated web providing additional stiffness without adding weight, the other mains being ribbed circumferentially and radially. Each cylinder is completely surrounded by a water jacket, and the overhead valves are operated by push rods, the camshaft being mounted as high as possible in the block, in order that the push rods shall be short.

To secure silence, the rocker is maintained in contact with the valve end by light compression springs between the top of the cylinder head and the push rods. The camshaft drive is by double chain located at the back of the engine, the view being that this is nearest the nodal point of vibration. Tension of the driving chain is controlled by an Alvis chain tensioner and chain flutter is eliminated by the use of a shoe on the tight side of the chain and spaced $\frac{1}{16}$in. from it. The cast iron camshaft has slow approach type cams hardened at the tips. The whole of the base of the crankcase is covered by a plate and the sump is mounted underneath the rear half of the crankcase. There are two holes through the plate, one for the oil pump drive and the other for the oil return. Oil collected from a floating filter is delivered to the main gallery up the pump drive casing. It is conducted by oil ways drilled in the block, there being no separate pipes. The oil capacity is $1\frac{1}{2}$ gallons.

Water enters the cylinder block at the bottom left-hand side, passing through a cored passage to a pump which forces it through a copper tube running the length of the head, thence through perforations to the hottest parts of the head. It returns via the thermostat housing, which is cast integrally with the front of the head, thence to the block or to the radiator as directed by the thermostat. The by-pass passage is an internal drilling. The impeller shaft rotates on Hoffmann sealed water pump bearings. The fan belt, which is only $\frac{3}{8}$in. in width, is of rubber reinforced with rayon of high strength. The total water capacity of the cooling system is 3 gallons.

Both the induction and exhaust systems are built in the form of two three-cylinder units, the induction system being fed by a twin choke type of carburettor, the exhaust system being twinned throughout. The weight of the engine is approximately 560 lb. being 50 lb. heavier than the same Company's 14 h.p. four-cylinder unit.



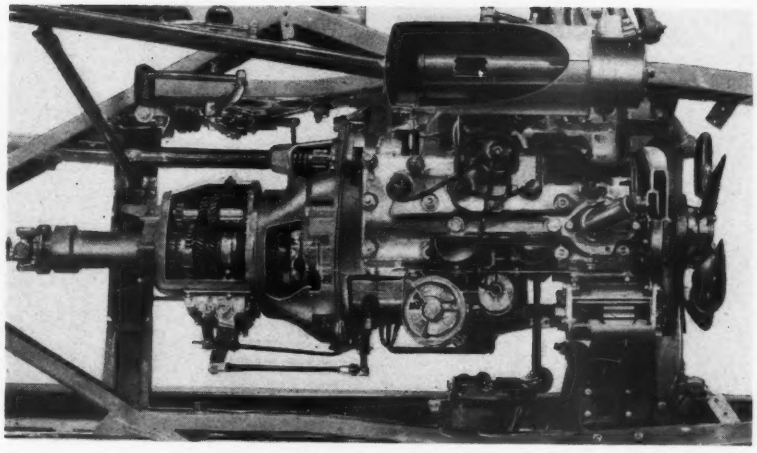
Rear view of Aston Martin twin overhead camshaft engine.

The neatness of the external appearance of this engine is materially assisted by the use of a cast aluminium cover plate over the ignition leads. There is an air passage the complete length, through which air is forced by the fan.

A marked contrast in appearance is the Chevrolet engine. No effort has been made for a good looking exterior, but this can be no reflection on its performance or length of life. This Canadian Chevrolet engine has a bore of 3½in. and a stroke of 3¾in., the capacity being 3,549 c.c. and the output 92 b.h.p. at 3,400 r.p.m. Compression ratio is 6.6 : 1. It has overhead valves operated by push rods.

For the first time, the Ford Company have produced two new engines. They have overhead valves and one is a six-cylinder. These engines so far as possible have common dimensions and they are designed to "over-square" dimensions. The bore is 3.125in. (79.37mm.) and the stroke 3in. (76.20 mm.). The capacity of the four-cylinder engine is 92 cu. in. (1508 c.c.) and of the six-cylinder engine, 138 cu. in. (2262 c.c.). The compression ratio is 6.8 to 1, the output being, in the case of the four-cylinder engine, 47 b.h.p. at 4,400 r.p.m. and 74 lb. ft. torque at 2,400 r.p.m. (old R.A.C. rating 15.63 h.p.) and for the six-cylinder engine 68 b.h.p. at 4,000 r.p.m. and 112 lb. ft. torque at 2,000 r.p.m. (R.A.C. rating 23.45 h.p.).

The new Fords are evidently intended to give vastly superior performance yet the engines are essentially easy to produce. The cylinder block and crankcase are integrally cast in iron, the detachable cylinder head also being cast iron. In general form the engine casting is simple in design and therefore simple to cast. It is reasonably robust and it should not be troubled with distortion. Complete water jacketing round each cylinder is provided.



Plan view of Humber "Hawk" power unit.

Several novel features have been adopted in the head, the combustion chamber being of wedge form, the apex being at the right-hand side of the engine. The overhead valves are in line but inclined, to bring them approximately central. The 14mm. long-reach sparking plugs are set into the apex of the wedge-shaped space. It is obviously intended that with the reasonably high compression ratio, poor petrol may be used without pinking.

The valves are operated by push rods, screw and lock nut adjustment being provided at the end of the rods. Single valve springs are employed with unequal coils to overcome surge. The so-called "autothermic" split skirt pistons carry two compression and one scraper ring above the gudgeon pin. The steel connecting rods have pinch bolt type small ends.

The crankshaft and camshaft are steel castings, the camshaft drive being by duplex chain. Water circulation is aided by an impeller, the triangular belt drive encircling both the impeller, on which is mounted the fan, and the dynamo. The engines have coil ignition and a 12-volt circuit is used.

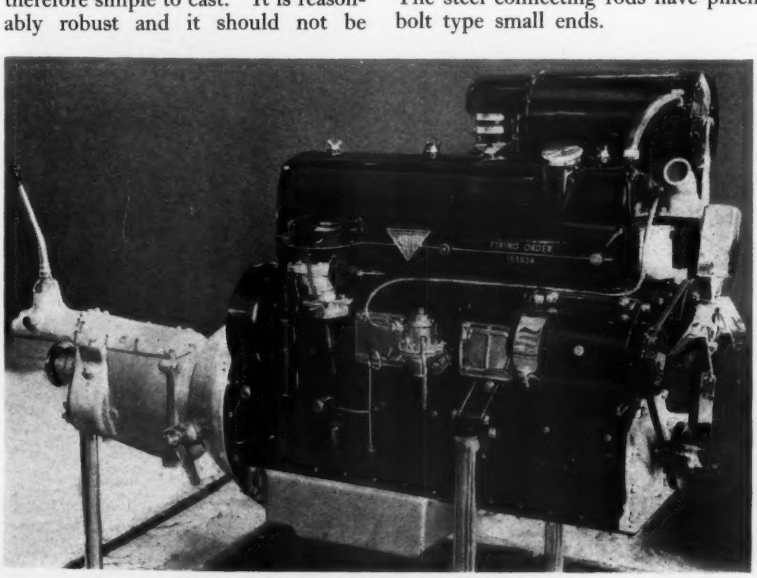
The four-cylinder engine has a three-bearing crankshaft and the six-cylinder has four bearings. Pressure lubrication is employed with a full flow filter mounted on the off-side of the cylinder block. A pressed steel sump holds 6.5 pints on the four-cylinder engine and 8 pints on the six-cylinder engine. The engines are mounted on rubber at three points.

The engine fitted to the Austin A40 sports model has two S.U. carburettors, the output being 46 b.h.p. at 4,400 r.p.m. and 60 lb. ft. torque at 2,500 r.p.m. as against 40 b.h.p. at 4,300 r.p.m. and 59 lb. ft. torque at 2,200 r.p.m. for the standard model.

Some vehicles have engines of outside make, such as Morgan with a Standard engine, Jensen with Austin and Allard with Ford. An unusual combination is the Healey chassis with a 3.8 litre six-cylinder o.h.v. Nash engine. This is modified in various ways and fitted with twin carburettors, so that the power is raised to 180 b.h.p.

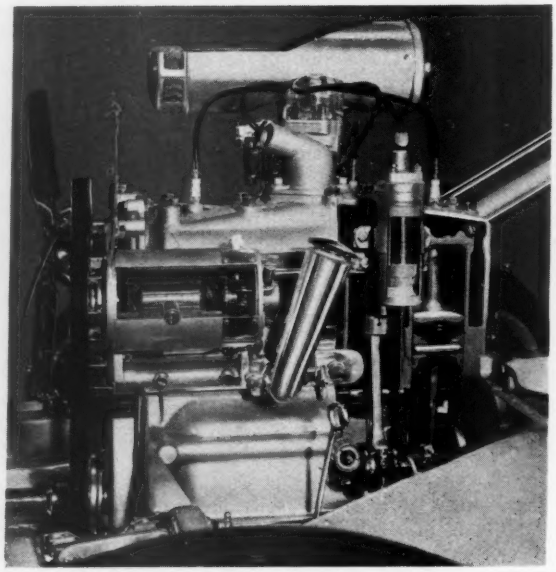
The 1477 c.c. four-cylinder side valved Morris "Oxford" engine has had a slight modification made to the shape of the combustion chamber near the valves, the major effect of which has been to reduce the compression ratio from 6.8 to 1 to 6.6 to 1. The gas flow characteristics have also been improved and the maximum power is now 41 b.h.p. at 4,000 r.p.m. as against 40.5 b.h.p. at 4,200 r.p.m.

The Nash "Ambassador" six-cylinder engine is 3⅜in. by 4⅜in. bore and stroke, the cubic capacity being 234.8 cu. in. It has push rod operated



The new Alvis 3-litre engine.

Lancia "Aurelia" V.6 engine.



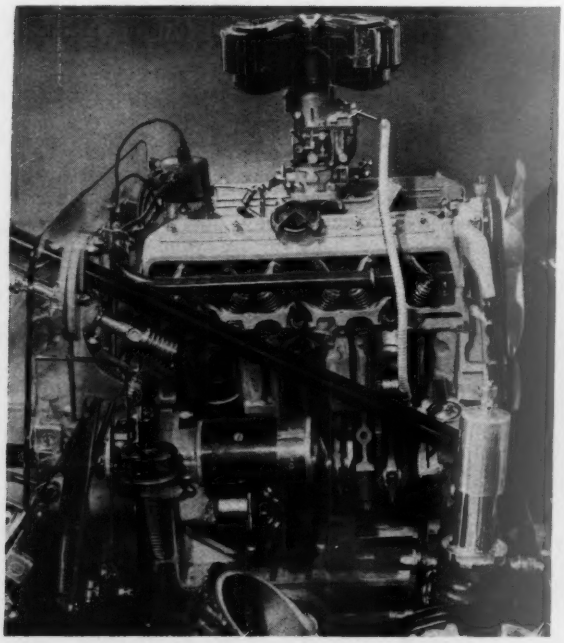
Left side of Hillman "Minx" engine.

overhead valves, a seven bearing counter-weighted crankshaft and an aluminium alloy cylinder head. 7.3 to 1 compression ratio is employed, the output being 115 b.h.p. at 3,400 r.p.m.

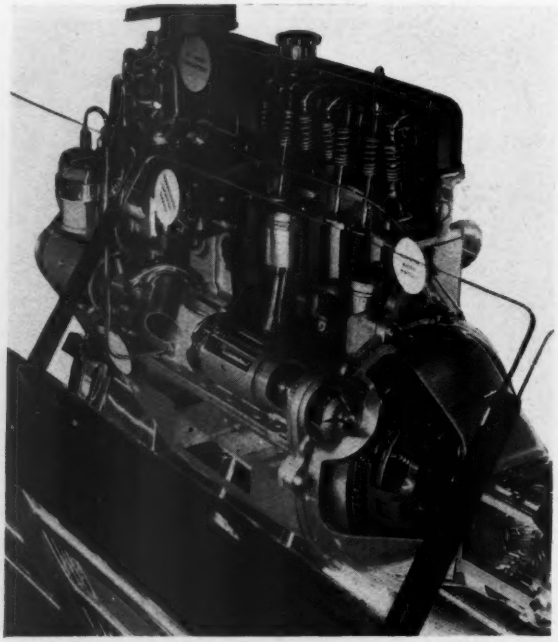
Packard changes for 1951 include the dropping of the well-known 160 b.h.p. eight-cylinder engine, leaving only two basic types, the eight-cylinder of 288 cu. in. and that of 327 cu. in. The models "200" exhibited have the 288 cu. in. engines of 3½in. bore and 3¾in. stroke. The compression ratio is 7 to 1 and maximum power 135 b.h.p. at 3,600 r.p.m. The same compression ratio is used on the 327 cu. in. engine but on those models using "Ultramatic" drive, higher ratios with slightly increased output are employed.

Vauxhall continue the Velox and Wyvern models, the Velox having a six-cylinder o.h.v. engine of 69.5 × 100 mm. bore and stroke, the capacity being 2275 c.c. With a compression ratio of 6.75 to 1, it gives 58.3 b.h.p. at 3,500 and 106.5 lb. ft. torque at 1,100 r.p.m. Points of interest are the connecting rods which are split at an angle of 35 deg. with the shank axis. The caps are located by broached serrations and are secured by setscrews. The ⅝in. diameter gudgeon pins are clamped in the small ends, a practice which is becoming more general. The piston crowns are shaped to agree in general form with that of the combustion chambers round the slightly inclined inlet valves, thus a measure of "squish" towards the main part of the chamber is given.

The valves are inclined to left and right so that the exhaust valves are on the off-side of the cylinder head in the recesses, which form the main com-



Right side of Lancia "Aurelia" engine.

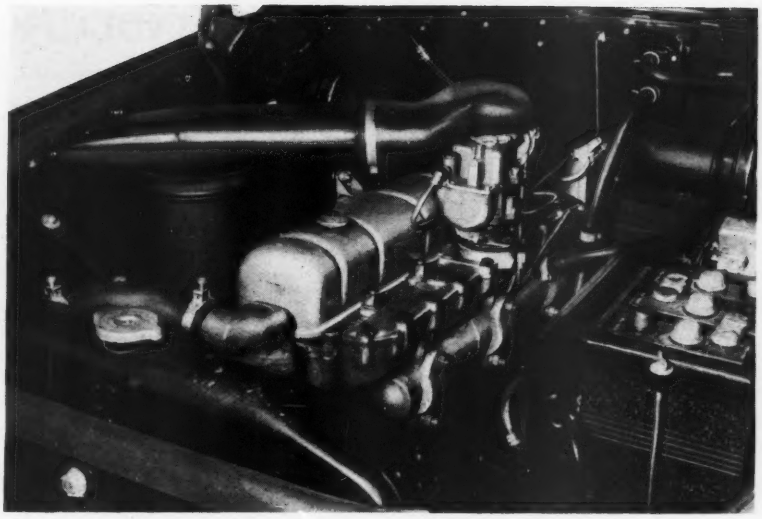


Vauxhall "Velox" engine showing valve arrangement.

bustion chambers, into which the sparking plugs project. The inlet valves are on the near-side at a lower level. Another feature is the strength of the valve springs, which are made of ground and shot-blasted wire 0.172in. in diameter and have a load with the valve open of 120 lb.

Probably the most interesting of the newcomers is the Lancia "Aurelia". It is a V-six of compact dimensions, but the angle of the cylinders is 60 deg., in marked contrast to the former Lancia narrow V angle at 22½ deg. In order that each connecting rod should have a separate crank throw, the bores are staggered. Wherever possible aluminium has been used, the two cylinder blocks being cast in one with the upper half of the crankcase, a separate casting forming the remainder of the crankcase, also the sump. This casting is externally finned for its complete length to aid cooling. The cylinder heads and rocker covers are also cast in aluminium and hardened cylinder liners are fitted. These seat on faces machined on the top of the block casting and are sealed at the base by twin rubber rings.

The combustion chambers are of hemispherical form, the piston crowns being flat and the two valves per cylinder are inclined to each other in a fore and aft direction at an angle of 52 deg. Operation is through an unusual type of rocker, rather in the form of a double bell crank, the rotational axis being at right angles to the centre line of the engine. The rockers are mounted in pairs in blocks fastened to the cylinder heads.

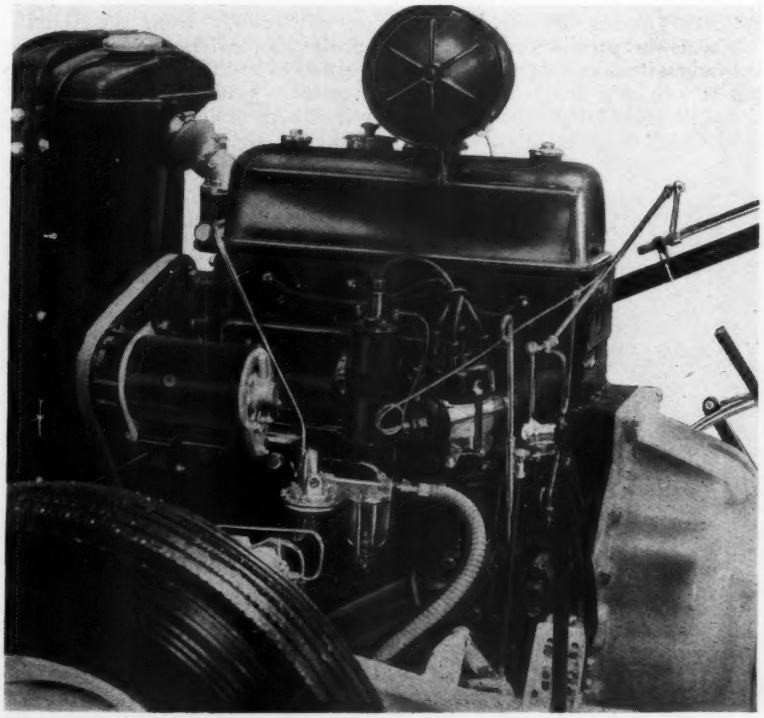


Nash six-cylinder engine showing "exhaust pipe" manifold.

The hollow aluminium push rods are all operated from a single camshaft which has twelve separate cams and is located in the junction of the V of the cylinder blocks. It is driven by a duplex chain at the front of the engine. The fully machined crankshaft is very short, the webs and balance weights being therefore rather large in outline. There are four main bearings 54mm. in diameter, running in white metal lined bronze shells; the crankpin diameter is 44 mm.

The distributor is mounted within the V between the rocker covers at the back of the engine and is driven by a vertical shaft through gearing at the end of the camshaft. This vertical shaft is also continued downwards to form the drive of the oil pump. From the pump, oil passes through a large filter having a washable element in an aluminium housing, which is vertically mounted towards the rear on the left-hand side of the engine. The housing also carries the relief valve which has a readily accessible external adjustment. The water pump has a bronze centrifugal type impeller in an aluminium body which is mounted between the two cylinder blocks. Coolant enters the cylinder blocks direct from the radiator and is drawn off past the heads by the pump. Two thermostats are employed, one in the cooling system in the outlet to the radiator header tank, the other inside the tank operating a set of radiator shutters. A triangular belt at the front of the engine drives dynamo, water pump and fan. The diaphragm type petrol pump is mounted on the right side of the engine and is driven by a plunger from the camshaft.

The bore of 70mm. and stroke of 76mm. gives a swept volume of 1,754 c.c., a compression ratio of 6.85 to 1 being employed. The output is 56 b.h.p. at 4,000 r.p.m., the maximum b.m.e.p. being 110 lb. sq. in. at 2,750 r.p.m. and maximum torque 78 lb. ft. within the range 2,500 to 3,000 r.p.m. The engine is rather firmly mounted on four rubber pads and as both clutch and gearbox are adjacent to the final drive, the engine terminates in a spider to carry a flexible rubber coupling.



The new Lanchester 2-litre four-cylinder engine.

CARBURATION AND INDUCTION SYSTEMS

Few Departures from Conventional Design

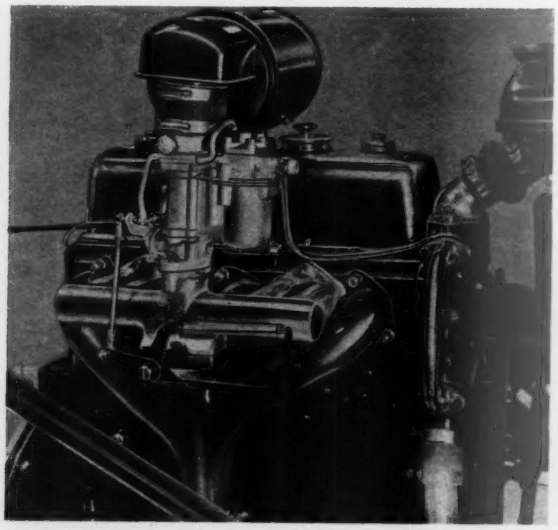
ALTHOUGH a number of new engines were exhibited for the first time, there was little departure from conventional design in induction systems or carburation generally. The increased cost of motor spirit must inevitably concentrate more attention upon fuel consumption in terms of miles per gallon, but engineers have long come to the conclusion that there is no quick and easy road to radical improvement in this direction. Every so often some revolutionary scheme appears, which is claimed vastly to improve petrol consumption, but few survive the initial tests. So many factors in the design of the engine and the vehicle can affect this most vital aspect of running costs. Every design of engine has a definite limit in its capabilities in burning lean mixtures, both at full and partly open throttle. Having determined this, and with the carburettor metering specified to cover these limits, the matter does not end. It remains to ensure that the minimum power is required to propel the vehicle along the road.

Here, the power/weight ratio and tractive resistances have an enormous influence upon the fuel consumed. An engine may be most highly developed and economical, yet if it is made to propel a heavy vehicle its mileage petrol consumption may be very poor. On the other hand, if an engine of indifferent efficiency is put in a very light car, its petrol consumption may be something to marvel at, owing to the power/weight ratio. Petrol consumption must be built, not only into the engine but into the vehicle also. Another most important factor, which is not taken really seriously by most British manufacturers, is the matter of rapid warming up from cold. It is significant that of all the motor car manufacturers producing vehicles in this country, only one tackles the "warm-up" period by incorporating the thermostatically controlled hot-spot.

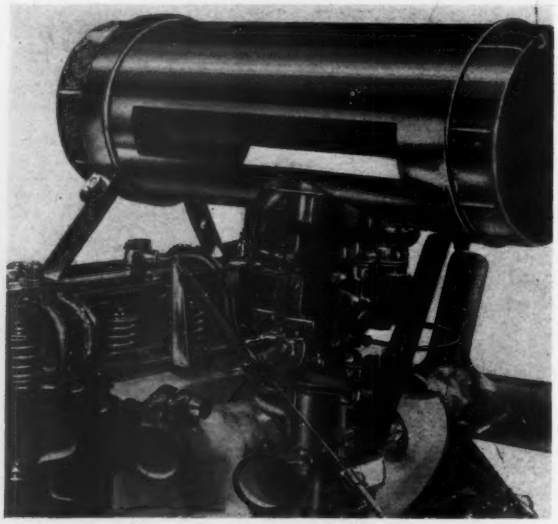
Petrol injection appears to have made no progress, and carburettor design indicates no radical change, although in America the "side-entry" downdraught seems to be gaining some ground. This scheme is not new, but is a modern adaptation of a very old design. The aim of the present project is to retain the downdraught carburettor without incurring the disadvantages of the conventional downdraught instrument, chief of which is the high bonnet clearance. The construction of the "side-entry" downdraught carburettor also lends itself particularly to a design which is most beneficial from the vapour lock viewpoint. The metering elements are conventional, having the usual idling and progression system, with economiser devices for lean mixtures at part throttle, full throttle enrichment, accelerating pump, and completely automatic chokes for cold starting. The somewhat peculiar arrangement of the various items may appear different, but actually this design functions in the usual manner. A disadvantage of this scheme would seem to be in the matter of volumetric efficiency, owing to the sharp turn imposed upon the entering air.

However, this form of downdraught has not yet been produced in this country, and as long as bonnet lines and engine and manifold position permit the employment of the conventional instrument, there is perhaps no real need for it. As far as the open choke type of carburettor is concerned, as represented by the Zenith, Zenith-Stromberg, and Solex in this country, and Carter, Ball and Ball and Bendix-Stromberg in America, all are of the downdraught pattern. From Italy the Weber carburettor also evidently favours the downdraught system, although horizontal versions are shown on the Special Sports Alfa-Romeo. On the other hand, the products of the only exponent of the "constant-vacuum" principle, the British made S.U. are almost invariably of the horizontal type. The open-choke carburettor seems to have entirely ousted the constant-vacuum instrument in the United States, and also on the Continent.

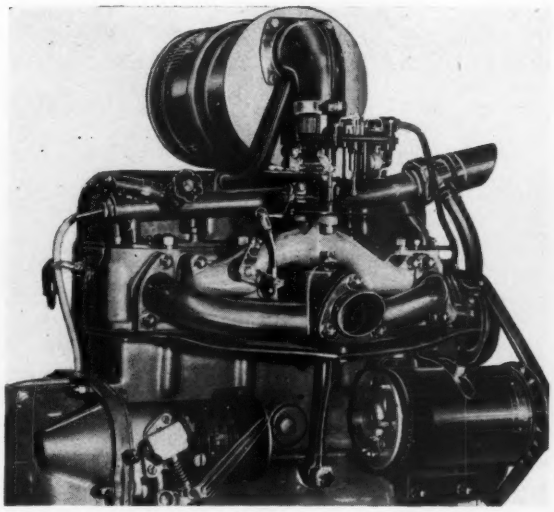
Nearly all the larger models of the open-choke instruments embody multi-phase economiser systems, together with accelerating pumps. The economiser devices are automatic and may be operated either by manifold depression or mechanically from the throttle spindle. Likewise, the accelerating pumps can be suction or mechanically operated. With most Solex carburettors both devices are suction operated, although sometimes the dia-



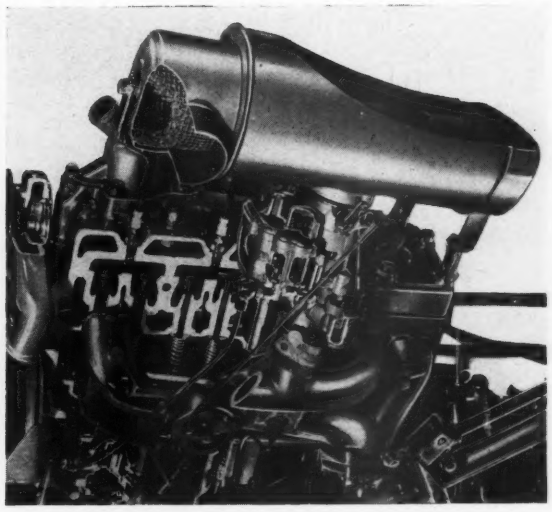
Lanchester Fourteen carburettor and manifolds.



Standard "Vanguard" induction system.



Fiat 1400 induction system.



Humber "Hawk" with automatic choke.

phragm pump is mechanically controlled by linkage from the throttle. Most Zenith and Zenith-Stromberg carburettors have suction operated economy with mechanically operated accelerating pumps, as do most of the American carburettors.

Cold starting systems are fairly evenly divided between the off-set strangler valve with linked fast idle mechanism, and the auxiliary starting carburettor. Nearly all Zenith, Zenith-Stromberg instruments, and all the American carburettors, have the off-set, automatic strangler valve with linked fast idle mechanism. Solex, on the other hand, embody the Solex starter carburettor auxiliary system on all models. Fully automatic cold starting systems, as exemplified by the "automatic choke", are an almost universal fitting on American cars, although not so general in this country. Among British cars on which it is standard equipment are all models of Rolls - Royce, Humber, Sunbeam - Talbot, the Austin Sheerline, the Jensen four-litre, and most Armstrong-Siddeley models. With the S.U. carburettor, the majority of installations employ the hand - operated starting device whereby the needle jet orifice is lowered manually. An automatic cold starting system is also supplied. This takes the form of a small auxiliary carburettor, automatically brought into operation by a thermostat situated in the coolant circulation system. The thermostat operates a solenoid switch when cold, which brings the auxiliary starting carburettor into action, and cuts it out when the coolant has attained running temperature. This system is employed on a number of British cars.

Air silencers are almost universal, and there are a variety of different types employed. Most export conditions demand an oil-bath air cleaner also. Some manufacturers specify an air silencer for "Home" conditions, with the addition of an oil-bath cleaner for "Export". Others use a combined air silencer and cleaner, where both silencing and cleaning elements are combined in a single unit. Others, for example on the Sunbeam-Talbot "90" Mk. 2, employ a "T" type air silencer with an oil-bath air cleaner in series, for both "Home" and "Export". A commendable point on American air cleaners is the quick-release screw clip, with a projecting handle and easily accessible. It is a practice British manufacturers might well follow.

Regarding the fuel-feed system, this is almost invariably by proprietary pump, which draws the fuel from a tank located generally at the rear of the chassis, and passes it to the carburettor under a small positive pressure, usually between $1\frac{1}{2}$ and $3\frac{1}{2}$ p.s.i. By far the most widely used pump is the A.C. mechanically operated diaphragm type, usually attached to the side of the engine crankcase and worked off the engine camshaft. All American cars appear to employ it, and in some instances the unit incorporates an extra diaphragm system, which serves as a booster to the windscreen wiper when the engine suction is low. In Britain some manufacturers, including the Nuffield Group, use the S.U. electric fuel pump. This is based on a diaphragm operated by a solenoid with an automatic switch. Some manufacturers employ a twin S.U. pump. Rolls-Royce and Jaguar are among these.

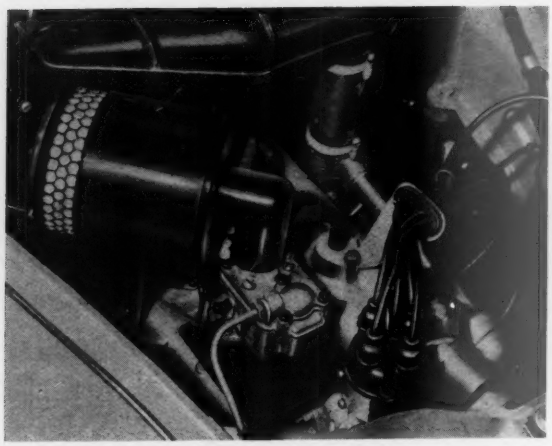
Although there is usually a disc gauze filter in the fuel pump, and another small cylindrical one at the carburettor union, a few makers fit an additional filter of the detachable glass bowl type. In some cases this is integral with the A.C. pump, while in others it is an extra component. On the Rolls-Royce Silver Wraith, the bowl filter is located at the rear of the chassis, between the fuel pump and the tank.

Induction Systems

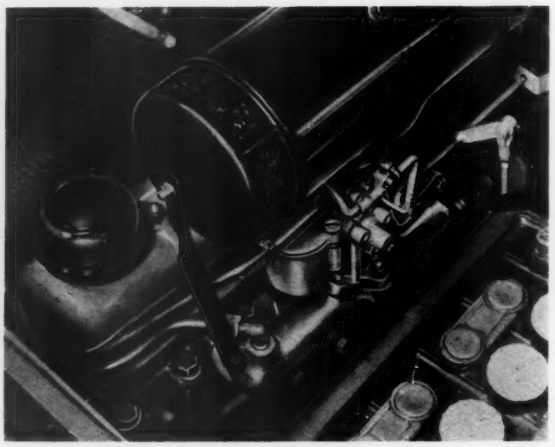
There is still much variety in the design and construction of British induction and exhaust systems. On American vehicles design appears to have settled down to the downdraught carburettor, usually equipped with automatic choke, feeding a cast iron induction system, with the exhaust manifolds on the same side. The thermostatically controlled hot-spot is general, and there is no doubt that that it is a valuable contribution to rapid warm-up from cold with its attendant improvement in fuel consumption and engine life.

On British vehicles the wide variety of induction tract port arrangement, shape, carburettor form, downdraught or horizontal, hot-spot by exhaust heat or water, provides continual interest for the technical observer. There is, however, no doubt that the most popular arrangement is a downdraught open-choke carburettor feeding an induction system located on the same side as the exhaust manifold, with a hot-spot of some kind between the two. With the four-cylinder engine, the most common arrangement is the two-port with siamesed inlet ports.

On six-cylinder engines, the three-port, with siamesed inlets, seems to hold the field, with the four-port system running it very close. There are not many six - port designs.



Fiat 500 C. with heat shield.



Ford "Consul" induction and exhaust manifolds.

Straight-eight engines are usually carburetted on the twin gallery tract, fed by a downdraught dual carburettor as exemplified by Buick, etc. The increasingly popular V.8 power unit is almost invariably fed by a dual downdraught carburettor, mounted on a single manifold casting in the vee. The casting embodies a complicated system of interleaving tracts supplying the eight cylinders.

Two Cylinder Engines

Panhard and Levassor retain the air-cooled twin cylinder opposed engine on the Dyna model. A single downdraught Solex carburettor is employed, bolted to a small casting containing the riser "T" junction above the centre of the engine. From the riser casting two long steel tubes run to the cylinder heads, one on each side of the engine. These tubes actually form the main induction gallery, and feed an inlet port at the rear of each cylinder head. A local hot-spot is formed by a jacket surrounding the riser junction and contained in the casting. The jacket is fed with exhaust gases by two steel tubes of somewhat smaller diameter than that of the induction passages, taken from each exhaust pipe adjacent to the cylinder heads.

It might appear that the two long unheated induction pipes could cause precipitation in cold weather, resulting in poor drive-away characteristics from cold. This may be counteracted, however, by the fact that the cylinders are air-cooled, and thus heat up rapidly. Fuel is fed by a mechanical fuel pump, and a flat cylindrical air silencer is fitted. The exhaust ports are to the front, from which the two exhaust pipes are taken down under the engine to the rear of the chassis. At a point half-way the two pipes merge into one, and pass into the single exhaust silencer fitted lengthwise in the chassis. A large sheet steel plate shields the hot-spot from the fan draught.

Four Cylinder Engines

On the new Ford power units the induction and exhaust systems are very different from anything produced hitherto. Both engines now have overhead valves, and on the four-cylinder 1½ litre Consul, the induction manifold is of the two-port pattern, feeding siamesed inlet ports. Situated on the near side, the manifold is of aluminium, a reversal of previous Ford practice. Most unconventional, however, is the arrangement of the exhaust manifold and hot-spotting. Instead of the usual exhaust manifold casting, an extension of the exhaust pipe itself is secured to the side of the cylinder head. This scheme is not new, however, having been employed by Nash with success for some time.

On the Ford engine, a hemispherical channel is machined along the length of the cylinder head on the near side, into which the exhaust ports from the cylinders open. Into this channel fits the exhaust pipe, orifices in the pipe aligning with the exhaust ports in the head. The pipe is clamped into position by two pressed steel clips, secured by studs and nuts. In addition, a four-bolt extension of the aluminium induction manifold above, carries a hemispherical groove, which fits over the outer wall of the exhaust pipe at this point. This aluminium extension not only provides an extra clamp for the pipe, but also forms the hot-spot for the riser "T" above. The exhaust pipe is closed at the rear end, the front curving down and round to the rear in a curve of somewhat short radius, and thus passes down to the silencer. Carburation is by a downdraught Zenith V.T. type carburettor, with an A.C. air silencer of the "T" type, arranged fore and aft. This form of exhaust system is also employed on the Ford six-cylinder Zephyr model.

The engines of the Vauxhall Wyvern and Velox are the only British designs that incorporate the American type of thermostatically controlled hot-spot. In the case of the four-cylinder Wyvern, the induction manifold is on the near side of the engine, and is of cast iron, the gallery of which is ∩ section, changing to circular at the cylinder ports. In plan view, this two-port manifold forms a continuous semi-circle, with the downdraught Zenith VIG carburettor in the centre. There are thus no port branches as such, the whole tract forming one sweeping curve from port to port. At about two inches from the centre line of the riser, the tract falls on either side about 1½ inches to the cylinder ports. Particular care is taken to ensure that the internal walls of the tract are smooth and free from casting ridges, etc., and the whole scheme shows evidence of careful thought in design. Surrounding the riser and gallery "T" junction is a jacket, the four-bolt flange of which aligns with a similar flange on the casting of the four-port exhaust manifold below.

There is thus a box in the exhaust casting below the jointing flange, and a flap valve inside the box, mounted on a spindle parallel with the crankshaft, is arranged to direct the exhaust gases up and around the riser jacket, or directly into the exhaust pipe. A bi-metallic thermostat is mounted on the rear projecting end of the spindle, the outer end of the spring being fixed to the casting, the inner end to the spindle. When the engine is cold, the thermostat spring turns the internal flap valve to a position where the exhaust gases are directed up and

around the junction of the riser.

As the engine warms up, the thermostat spring absorbs heat from the exhaust manifold casting, and gradually loses tension, so permitting the flap valve to open progressively and permit some of the exhaust gases to escape direct into the exhaust pipe. When the engine is hot, the spring will have lost all tension and the valve will be wide open, directing the gases away from the riser jacket and direct into the exhaust pipe. In order to assist the opening of the valve, it is mounted upon the spindle in such a manner that there is a greater area of valve plate on one side of the spindle than on the other. In addition, a bob-weight is attached to the front end of the valve spindle, and a stop pad limits the open position. Mounted direct to the intake of the carburettor is an A.C. air silencer of the "T" type, and fuel is supplied by a mechanical fuel pump on the opposite side of the engine.

Also of the two-port design, with induction separate from the exhaust, is the Austin A.40, but a hot-spot of the "thin-plate type" is employed. Mounted on the near side of the engine, the induction manifold is of round section, fed by a downdraught Zenith carburettor. Short in length, the galleries leave the riser and curve inwards to the cylinder head ports, rising slightly from the riser on the way. The two outer branches of the exhaust manifold fall inwards to form a V, in the centre of which is the branch from the two centre ports. An upward extension of this branch forms the base of the hot-spot flange, which bolts to that of the induction manifold. The metal inside the flanges of both manifolds is cut away, and a copper plate is bolted between the two. The temperature response is thus very rapid. Located slightly to the right is the exhaust off-take, between the rear port branch and the centre one. A drain tube is taken from an extension on the induction hot-spot flange, and a "T" type air silencer is fitted. Very similar are the inlet and exhaust systems of the Austin A.70, the carburettor in this instance being a larger Zenith of the economiser type. Both engines are equipped with A.C. mechanical fuel pumps.

Morris employ a two-port induction system on the Oxford, but the manifolds are combined in a single casting. Placed above the exhaust, and fed by a horizontal S.U. carburettor, the round section tract curves downward and inward to the ports, the length of the tract being short. A combined drip-tray and heat shield is located between the carburettor and exhaust manifold, and an A.C. air silencer lies across the engine. An S.U. fuel pump is fitted.

Twin carburettors on the Austin A40 sports model.

A somewhat similar system is employed on the Wolseley 4-50 engine, the horizontal S.U. carburettor having an air silencer of the "T" type. Also of the two-port design, but of the straight-rake variety, the induction manifold of the Morris Minor is cast integral with the exhaust manifold and situated above it. The induction gallery tract is circular in section and straight, the two port branches leaving the gallery at right angles and falling some two inches to the ports. Buffer-end extensions are provided at the ends, and a single horizontal S.U. carburettor supplies the mixture. Fuel feed on all Morris and Wolseley models is by S.U. pump. Integral induction and exhaust manifolds are also employed on the M.G., equipped with a horizontal S.U. carburettor with S.U. pump, the Hillman Minx, with a downdraught Solex carburettor and mechanical fuel pump, and the Humber Hawk.

In the case of the Hawk, the induction tract follows the changing section through 180 deg. as on the Humber Snipe, but in this instance the manifold is a two-port, instead of a three-port one. A downdraught Zenith-Stromberg carburettor, with automatic choke is employed, a large combined oil-bath cleaner and air silencer being fitted.

It is surprising to find so small an engine as the Renault 760 c.c. rear engined model equipped with separate manifolds and a thermostatically controlled hot-spot. It is a four-cylinder, and the induction and exhaust manifolds are on the near side the induction being of cast aluminium. Of round cross section, the two galleries leave the riser "T" with a slight upward slope, then take a right angle bend to the ports at an angle of about 45 deg. The riser "T" junction is jacketed, and fed with exhaust gases by means of an off-set mounted flap valve as on the Vauxhall Wyvern engine. A bi-metallic thermostat is mounted on the flap valve spindle at the rear. While the two centre ports of the exhaust manifold feed downward into the flap valve box, the two outer exhaust port branches rise over the branches of the induction system and then fall to join the exhaust manifold adjacent to the centre port branches. A downdraught Solex carburettor is fitted, and an air silencer is located in the side of the engine compartment. Fuel is supplied by a mechanical fuel pump mounted on the other side of the engine.

A feature of the Triumph Mayflower induction system is the unusual length of riser provided. This is all to the good, and is not often encountered these days on account of restricted bonnet space. In the Mayflower scheme a long downdraught riser is provided without raising the height of the carburettor unduly, by placing the induction system below the exhaust. A downdraught Zenith "V" type carburettor supplies the mixture. From the inverted "T" junction the round section gallery sweeps right and left, and inward to the ports, rising slightly at the bends. The four-port exhaust manifold is cast integral with the induction, the two being joined as usual in the centre. The hot-spot so formed heats the inside of the long riser for most of its length, and also the bottom of the junction. From the centre the two outer exhaust branches curve up and outwards, over the induction tract, and drop again to the two outer exhaust ports.

The exhaust off-take is in the centre of the casting, below the riser. The riser is inclined to correct the transmission angle of the engine. A crankcase breathing system is arranged, one pipe connecting the riser with the side valve tappet cover, while another is taken from the air entry end of the "T" type air silencer to the oil filler cap.

The Standard Vanguard engine has an induction system that combines the single and dual gallery schemes. Although the riser is not as long as on the Triumph Mayflower, it is still longer than most, a feature to be commended. Mounted on the off side, the cast aluminium induction manifold is above the exhaust, with a contact hot-spot between the two. The round section galleries leave the riser and turn in towards the cylinder head. When the right angle turn is made the two branches split into two, the four port orifices aligning with the four ports in the head. This is a somewhat unusual arrangement, and is in effect a two-port system feeding two siamesed head ports, but with the siamesed bifurcation brought out further from the inlet valves. A "T" type air silencer fits direct on to the downdraught Solex carburettor, and as in the case of the Triumph Mayflower, a special crankcase breathing system is incorporated. One tube is taken from the induction system, just below the riser, to the top of the rocker cover, and another from the near side of the crankcase to the air silencer.

The new Lanchester two-litre engine is equipped with a four-port induction system. This four-cylinder O.H.V. engine has both induction and exhaust manifolds on the off side, the induction being above the exhaust. The induction tract is of the straight-rake pattern, the round section gallery having four separate port branches that leave the gallery at right angles and in the horizontal plane. Of cast aluminium, the induction manifold is bolted to the four-port exhaust system below by flanges on both manifolds just below the riser "T" junction. This contact hot-spot is formed by a jutting portion of the exhaust manifold and is heated mainly by the gases from the two centre port branches. The two outer exhaust port branches sweep down on either side of the induction to meet those of the two centre ports, the off-take being in the centre. A downdraught "V" type Zenith carburettor bolts to the short riser, and between the two is a metal-asbestos shield to deflect heat from the exhaust away from the carburettor. A long cylindrical A.C. air silencer of the "L" type is fitted. The A.C. mechanical fuel pump, which has a detachable glass bowl filter, is located on the near side of the crankcase.

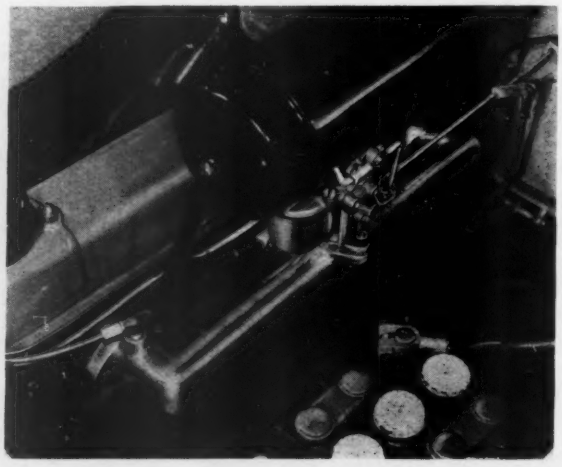
Exhibited in this country for the first time, the Fiat 1400 has either a downdraught Solex or Weber carburettor, feeding a four-port, round section induction manifold of aluminium. From the riser the main gallery falls towards the port branch bends, which turn sharply in towards the cylinder block, the manifold itself lying close to the block. The four port branches are not separate ones, but are arranged in pairs at each end of the manifold, so that it has the appearance of a two-port system. A vertical extension on the centre of the three-port exhaust manifold rises to form the contact hot-spot beneath the riser, this extension being necessary because the riser "T" junction is above the main gallery. From the induction portion of the hot-spot the mainfold drain is taken, a brass union being screwed into the casting.

A somewhat unusual feature in the exhaust system is the off-take from the exhaust manifold. This is in a horizontal plane, connection between the manifold and the exhaust pipe being made by a large three-hole flange located vertically. There is a pressed steel heat deflector plate between the carburettor and the induction riser, and in addition, a large deflector plate of similar material is situated under the entire length of the exhaust manifold, presumably to protect the starter and dynamo from radiated heat. Across the top of the engine is a cylindrical Fispa air silencer. While the sectioned engine was fitted with a downdraught Weber carburettor, that in the car had a Solex. It is believed that both makes are employed. The smaller o.h.v. Fiat, model 500-C, has two-port induction cast integral with the four-port exhaust manifold below, both being on the off-side. Here a small downdraught Weber carburettor is fitted, with a shield underneath to protect it from radiated heat.

A few engines of the sports variety employ twin carburettors, and among these is the new Austin A.40 Sports. Two horizontal S.U. carburettors are bolted to a pair of riser flanges, connected by a balance pipe. The carburettors are inclined, so that the air passage runs downwards to the cylinder block at an angle of some 30 deg. Disc type air silencers are fitted direct to the carburettor intakes. No alteration has been made to the twin carburettor assembly on the Austin A.90. On the 2½-litre Riley, the twin horizontal S.U. installation is retained. Each carburettor feeds into water heated riser castings connected with each other by a balance channel.

A good example of the twin-gallery induction system is that on the Sunbeam-Talbot "90" Mk-2 engine. This engine is slightly larger than its Mk-1 predecessor, but continues with

Thermostatic hot-spot on Kaiser "Henry J".



Ford "Zephyr" with "exhaust pipe" manifold.

the somewhat unconventional induction system that proved so successful on the earlier model. It is really an adaptation of the dual or twin-throttle body carburettor scheme on a four-cylinder engine, but using a single carburettor. The idea is to prevent or reduce the inevitable robbery of the charging mixture from one cylinder by another. A single downdraught Zenith-Stromberg carburettor supplies mixture to a double-gallery induction tract. The inlet valve ports are separate, so that there are four inlet ports in the cylinder block.

Of cast aluminium, the induction manifold has two separate induction tracts, an inner one feeding cylinders 2 and 3 and the outer, cylinders 1 and 4. The dividing wall between the two channels runs from the cylinder block flanges almost to the riser "T" junction, so that the inner openings of the four tracts are adjacent to the riser and the off-take of the carburettor. In cross section the four tracts are rectangular at the riser, changing to circular at the branch bends. From the riser the galleries sweep round and upwards to the cylinder ports. Below the induction system is the exhaust. Here the manifold is of the four-port type, the two outer branch bends curving outwards and down to meet the outlets from the two centre ports, where the hot-spot is formed.

The two manifolds are bolted together at this point, each flange being open with a thin copper plate of large area between the two. From this point the manifold drain is taken. As with all the Sunbeam-Talbot and Humber models, the lower end of the drain tube carries a non-return ball valve. The aluminium ball is some $\frac{1}{4}$in. in diameter, and is held up against its seat while the engine is running by the engine depression, so closing the orifice. This provides a manifold drain of ample proportions, while giving steady idling. An A.C. "T" type air silencer is fitted. In addition there is an oil-bath air cleaner attached to the chassis and connected to the air silencer by corrugated hose.

The air intake is at the rear of the radiator, which ensures absence of intake roar, not always easy to silence with a large four-cylinder engine. Incorporated in the Zenith-Stromberg carburettor is the automatic choke, operated by a bi-metallic thermostat. As on all Sunbeam-Talbot and Humber models, the system incorporates an automatic fast idle and progressive mixture gradient with engine temperature.

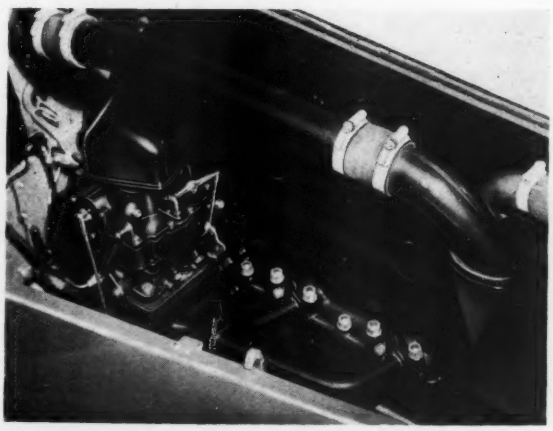
The only flat-four cylinder exhibited, the Jowett, retains the twin carburettor installation, with a downdraught Zenith carburettor bolted to each cylinder head, so feeding a pair of siamesed inlet valve ports on each side. A long balance channel runs across the engine to stabilise idling and low speed performance. An air silencer of special design is fixed to the underside of the alligator bonnet, with rubber connections so that when the bonnet is closed, the connections fit over the two air intakes of the carburettors. To protect the carburettors when the bonnet is lifted, wire grilles are fitted to the top of the carburettor intakes. The exhaust pipe from the off-side cylinder block runs round the front of the engine, where it joins the main exhaust pipe from the near-side cylinders.

Six Cylinder Engines

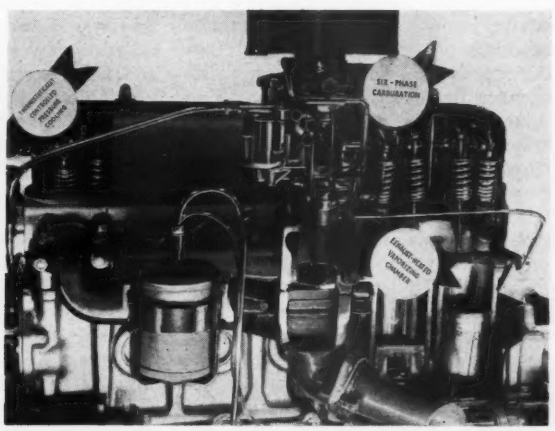
The popularity of the three-port layout with siamesed inlet valve ports remains, although it is by no means universal. On the Austin Sheerline, the three-port, round section induction, fed by downdraught Zenith-Stromberg carburettor, with automatic choke, is continued. Both inlet and exhaust manifolds are on the near side of the engine, the four-port exhaust manifold being below the inlet. The two castings are bolted together, the flanges being open and a copper plate hot-spot provided. From the riser the galleries rise somewhat to the outer branch ports, the turn being rather sharp. The exhaust manifold is a four-port, the inner ports being siamesed. The same power unit with identical carburation and induction systems is employed in the Jensen four-litre saloon.

Also embodying the three port system are the Humber Super Snipe and the Vauxhall Velox. On the Humber Super Snipe the downdraught Zenith-Stromberg carburettor feeds an induction tract of unusual pattern. Like the Austin Sheerline, the manifolds are on the near side, with the inlet above the exhaust, and a "thin-plate" hot-spot. For some years a feature of the Humber six cylinder induction design has been the changing section of the tract. The gallery leaves the riser as a flat rectangular section, with the major axis horizontal. Rising towards the outer port branch bends, the two galleries change section so that the major axis becomes vertical at the bend. Between the bend and the cylinder port, the section changes again, so that at the block the major axis is horizontal again. This change of section through 180 deg. is also employed in a modified form on the four-cylinder induction system of the Humber Hawk. This car also is equipped with the Zenith-Stromberg automatic choke. A manifold drain tube is fitted under the riser, and in common with all the Rootes engines, has a non-return ball valve.

Like the Ford Consul, the six-cylinder o.h.v. Zephyr engine has an unconventional exhaust manifold sys-



Rolls-Royce with dual downdraught carburettor.



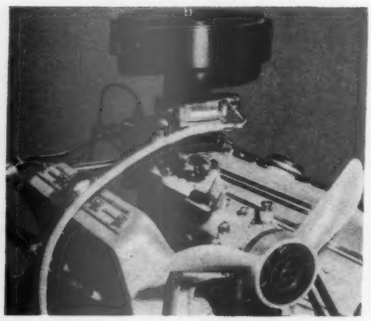
Vauxhall "Velox" with thermostatic hot-spot.

tem, based on a three-port induction manifold of cast aluminium. Careful investigation into mixture distribution is doubtless responsible for the form of the tract. The centre port branch leaves the riser at a point above the floor of the tract, and falls slightly to the cylinder port, probably to avoid excess liquid fuel passing into the centre pair of siamesed inlet ports. Leaving the straight gallery at right angles, the tracts of each end port have a helix cast on the wall, the purpose of which is to swirl the liquid content of the mixture and avoid an excess at the two end cylinders.

As in the case of the Consul model, the usual exhaust manifold casting is replaced by a continuation of the exhaust pipe itself. This is carried along the near side of the cylinder head and clamped into a hemispherical groove in the head by six pressed steel clamps. Holes cut in the pipe align with corresponding ports in the groove. The rear end of the pipe is sealed as before, the pipe leaving the cylinder block in a short-radius curve down to the rear, where it enters the silencer. An exhaust heated hot-spot is provided by an extension of the induction manifold casting, which clamps over the exhaust pipe below. It thus performs the double function of furnishing an extra clamping for the exhaust pipe to the cylinder head and also heating mixture. A "T" type air silencer fits direct on to the downdraught Zenith carburettor, which is provided with a hand strangler for cold starting. Fuel supply is by an A.C. mechanical pump on the opposite side of the engine.

On the Vauxhall Velox, the three-port induction with the thermostatically controlled hot-spot is retained. This form of hot-spot is also employed on the Vauxhall Wyvern. Of cast iron, the induction system is above the exhaust, the induction tract being of ∩ section. The scheme shows evidence of much thought in the control of the liquid content of the mixture. A downdraught Zenith carburettor is surmounted by a small air silencer direct on to the carburettor.

Among the American three-port systems is that of the Studebaker Champion. Following conventional American practice, both manifolds are of cast iron and incorporate the thermostatically controlled hot-spot, as used on the Vauxhall Wyvern. A downdraught Stromberg carburettor supplies the exhaust jacketed riser "T" junction, from which round section galleries extend right and left to the outer port bends. Both galleries rise towards the bends, the front more than the rear. The two centre exhaust ports feed the thermostat valve box, and so



Lancia "Aurelia" carburettor and induction manifold.

provide heat for the hot-spot. Fuel supply is by a mechanical fuel pump, which carries a glass bowl petrol filter on the suction side. Included in the pump assembly is the extra diaphragm system which serves as a booster for the windscreen wiper, a tube being taken from the riser to this section of the fuel pump assembly. The Stromberg carburettor incorporates the American type of hot-air automatic choke.

Chevrolet retain the three-port induction, with ∩ section tract and thermostatically controlled hot-spot. Instead of the Carter carburettor previously fitted, a downdraught Rochester instrument of new design is now employed. As with the Kaiser "Henry J" model, the Chevrolet carburettor has a hand strangler. These are the only two American cars shown to be so equipped. All the remainder have some version of the automatic choke.

A newcomer in the American field, the Kaiser "Henry J", is powered by a side valve six-cylinder engine with both inlet and exhaust manifolds on the near side. Of cast iron, the three-port induction manifold has a straight gallery tract of square cross section, falling from riser to port branches, while the branches, which leave the gallery at right angles to it, change into round section. The riser and gallery junction is exhaust jacketed, with a thermostatically controlled hot-spot fed by the six-port exhaust manifold below. Instead of being parallel to the crankshaft in the usual manner, the hot-spot valve spindle is at right angles to it, so that the projecting end of the spindle which carries the thermostat spring is on the outside of the hot-spot box instead of at the rear.

A large oil-bath air cleaner fits direct on to the intake of the downdraught Carter carburettor, which is unusual in having a hand controlled strangler. In common with most American units of this kind, the air cleaner embodies an innovation that might well be followed in this country, namely an easily loosened fastening so that the cleaner is quickly removed. A screwed clamp secures the cleaner to the carburettor air horn, the screw of which bears an extension terminating in a looped handle clear of the air cleaner body. This eliminates the fiddling with a spanner in the restricted and darkened space under the cleaner, when the cleaner has to be removed for washing out or to give access to the carburettor and other items.

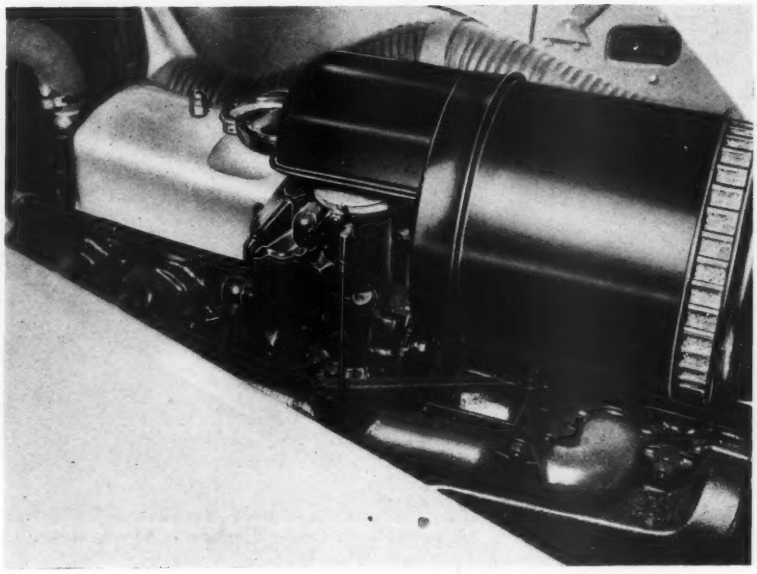
Also retaining the three-port induction systems are the De Soto, Chrysler, Dodge and Plymouth. De Soto and Dodge employ a downdraught Carter carburettor with the Sisson automatic choke. Unlike the more widely used form of automatic choke, the Sisson depends on a solenoid to close the strangler valve for the initial cold start, and does not make use of engine depression at all. It is, in fact, the only American automatic choke unit to be operated electrically, and the virtue of any such device is debatable. Having regard for the heavy loads already imposed on the battery, there does not seem much point in loading it still further. In winter conditions and with a low battery, when all available current is required at the starter motor and at the plugs, it seems inadvisable to employ the battery to operate the carburettor starting system also. The unit, which is self-contained, is secured to the exhaust manifold, and is connected to the carburettor strangler valve by a link-rod.

Four-port induction systems are less common than the three-port, and in most cases it is the two inner ports that feed siamesed inlet ports. Pontiac retain the four-port design and arrange the induction and exhaust in the reverse manner to that usually employed. While the two manifolds are on the same side of the engine, and the thermostatically controlled hot-spot is included, the induction manifold is below the exhaust. In these days of falling bonnet lines, there is much to be said for this scheme, and it is surprising that more attention has not been paid to the arrangement over here. The prevailing practice of placing the induction manifold above the exhaust has had the effect of shortening the length of the riser, never a good thing. With the manifolds in the reverse order, however, the carburettor is lowered bodily without sacrifice in riser length. The chief objection to this scheme is doubtless the closer proximity of the exhaust manifold to the carburettor, but with adequate shielding this should be overcome. In the case of the Pontiac

the downdraught Carter carburettor feeds a four-port gallery tract of round section. The six-port exhaust manifold is close to the cylinder block, while the port branches of the induction tract are sufficiently long to bring the gallery out and away from the exhaust. A large heat shield protects the carburettor from radiated heat. Starting is provided for by the hot-air form of automatic choke, and an air silencer bolts direct on to the carburettor.

A four-port system is also favoured by Kaiser on the de Luxe model. Here the manifolds are on the off-side and arranged in the conventional fashion, the inlet being above the exhaust. The manifolds are bolted together under the riser in the usual way, a thermostatically controlled hot-spot being provided at this point. Of rectangular section, with the major axis horizontal, the main galleries curving out to the two end ports are wider than the two centre branches, and the probability is that the gallery may bifurcate and feed two separate inlet valve ports at each end. Carburation is by a Carter downdraught carburettor, and the carburettor incorporates the automatic choke for cold starting. Among the British makes with a single carburettor, Morris retain the four-port system, arranged above the four port exhaust manifold, on the near side of the engine. Here the carburettor is a horizontal S.U., fed by an S.U. pump.

Exhibited for the first time this year, the new Alvis three-litre is an entirely new six-cylinder engine and has a dual carburation system. The carburettor is a dual downdraught Solex with 30 mm. throttle barrels. Arranged with the throttle spindle at right angles to the crankshaft, the two barrels feed into two separate wells, one under each riser, from which the two gallery tracts lead out fore and aft to their respective three cylinders. Of square section, the divided gallery is of the four-port type, the porting being somewhat unusual in that the two outer inlet ports are siamesed, while the two inner ones are single. The induction manifold is aluminium, bolted to the exhaust manifold under the riser in the usual manner. A hot-spot is provided under each riser well by the open exhaust flange, so that the gases play direct upon the floor of the wells, the thickness of the floor being only 4 mm. A manifold drain tube is taken from this point. From the riser portion of the induction manifold casting, the two square-section gallery tracts fall slightly to the outer port branch bends, which are 90 deg. turns, with the outer corner cut off at an angle of 45 deg.



Downdraught carburettor and automatic choke on the Jensen.

The two inner port branches are taken from the gallery before it begins to fall towards the outer bends, so that they drop to the cylinder ports, while the outer branches do not. Although the six-port exhaust manifold below is a single casting, it has two off-take orifices, one for each set of three cylinders. From the flange, the two separate exhaust pipes fall and curve away towards the rear of the chassis, where each enters an oval-section Burgess silencer. There are thus two separate exhaust tail pipes at the rear of the car. A long cylindrical A.C. air silencer of the "L" type is situated on the near side of the engine. Fuel supply is by a mechanical pump mounted on the opposite side of the engine.

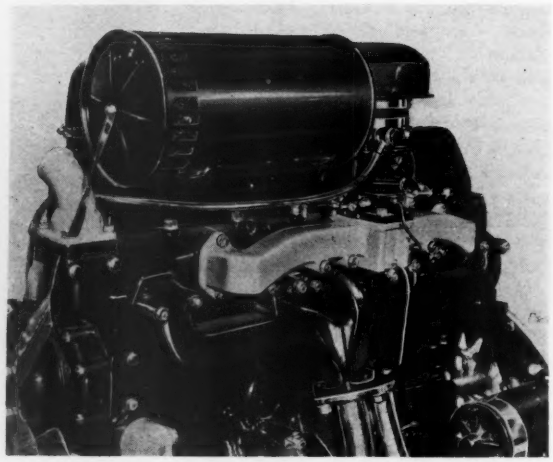
An interesting four-port design employing a dual downdraught carburettor is the six-cylinder Rolls-Royce Silver Wraith and Dawn. The cylinder head is the "F" type, with overhead inlet valves with side exhaust. This arrangement brings the inlet ports on the off side of the engine and the exhaust on the near side. The ducting is such that the two outer induction tract ports feed single inlet valves, while the two inner ones supply siamesed inlet valve ports. A dual downdraught Zenith-Stromberg carburettor, mounted with the throttle valve at right angles to the crankshaft, feeds the compound induction tract, the ducts being so arranged that the outer throttle body supplies the two front ports, and the inner barrel the two rear ones.

This arrangement is also employed on the Citroen, Hudson and Alfa-Romeo 2.5 litre sports model. It has superseded the earlier arrangement in which the throttle spindle was placed parallel with the crankshaft, so that the throttle valves directed the mixture to one side or the other. In appearance, the Rolls-Royce induction manifold is symmetrical, the gallery tracts being of square section, as are the port branches. The two inner port branches are close to the riser and leave the gallery rather sharply, while the outer ones curve in more gently to the cylinder head ports. All four branches fall some one inch to the head. The twin riser and gallery junctions are surrounded by a water jacket, in circuit with the engine coolant. A port and flange on the hot-spot casting bolts up to a port opening on the cylinder head and thus feeds the hot-spot jacket with hot water direct from the cylinder head.

The outlet for the water is taken from the bottom of the jacket, a pipe leading direct from that point to the water pump. A drain is fitted at the lowest point under the two risers. The carburettor, which is of the multi-stage economiser and accelerating pump type, also incorporates an automatic choke of the usual Zenith-Stromberg design, complete with automatic fast idle. An unusual feature of the installation is the fact that the bi-metal thermostat assembly is operated by the hot coolant instead of exhaust heat. As the exhaust system is on the opposite side of the engine, the hot-spot is water heated, and the recess for the thermostat unit is situated on the outside of the hot-spot jacket underneath the carburettor.

Fuel supply is by a twin-element S.U. pump mounted on the chassis,

Twin carburettors on the Lagonda.



Alvis 3-litre manifold system.

away from all engine heat. A petrol filter is arranged at the rear of the car, between the petrol tank and the pump. An air silencer of the "L" type is fitted. On the opposite side of the engine is the six-port exhaust system. The manifold consists of two separate castings, each having three port branches, the two inner ones being close together. The off-takes of both manifolds bend down at their inner ends, in the centre of the engine, to meet the forked casting at the top of the exhaust pipe, which passes to the twin silencers in the frame.

Also of the "F" head design, with o.h.v. inlet and side exhaust valves, the Bentley engine is equipped with a four-port induction system, the two inner ones being siamesed as before. The induction tract in this instance, however, is of the straight-rake pattern and of round section, with buffer ends some 1½in. long, the port branches being short and of square cross-section. Carburation is by two horizontal S.U. carburettors, some distance apart, between the outer and inner port branch at each end. A restriction in the centre of the gallery tract acts as a balance between the two sections of tract, so that the front carburettor feeds cylinders 1, 2 and 3, the rear carburettor Nos. 4, 5 and 6.

A water-jacketed hot-spot surrounds the junction of each horizontal riser with the main gallery, the hot coolant supply being taken from the cylinder head, from which two copper pipes lead over and along to each hot-spot jacket. A pipe connecting the underside of each jacket with the water provides the return circuit for the coolant. The two S.U. carburettors are arranged with the float chambers to the front. A large cylindrical air silencer lies above the valve cover.

An American example of the dual downdraught carburettor installation on a six-cylinder engine was shown by the Hudson Super Six. Here the induction tract is a six-port one, on the off side of the engine, but the design is such that the three-port branches on either side of the carburettor sweep inward to the risers, so that each throttle barrel feeds its three cylinders through separate tracts. As in the case of the Rolls-Royce Silver Wraith and Dawn models, the outer throttle barrel of the downdraught carburettor supplies the front three cylinders, while the inner barrel feeds the rear three. The throttle spindle is arranged in the now conventional manner at right angles to the crankshaft. In cross section, the induction tracts are square, and of cast iron, and beneath is the six-port exhaust manifold, the two being bolted together as usual below the carburettor.

A good length of riser is provided, and both risers are jacketed around their junction with the galleries, and fed with exhaust gas from the thermostatically controlled hot-spot below. The spindle of the flap valve is parallel with the crankshaft, the bi-metallic thermostat being located on the front end of the spindle. An unusual point is the metal tag on the end of the spindle, loaded by a small coil spring to a bolt on the casting above. This is presumably to prevent rattle from the spindle when wear occurs. The Carter carburettor incorporates the usual hot-air type of automatic choke for cold starting, the hot air pipe being lagged to conserve heat. For protection against exhaust heat, a steel shield is fitted under the carburettor. A large cylindrical oil-bath air cleaner is fitted on to the carburettor inlet.

A similar arrangement is used by Citroen on the six-cylinder model. Here, a dual downdraught Solex carburettor is mounted with the throttle spindle at right angles to the crankshaft, in such a manner that the outer throttle barrel supplies the rear three cylinders, the inner barrel the front three. The induction tract is virtually a four-port, the two outer branches feeding single inlet valve ports, while the inner two supply siamesed ports and thus feed two cylinders each.

Of cast aluminium, the induction manifold carries two separate tracts. There is no "T" junction of riser and gallery as such. Instead the risers curve down and outwards, the front one to the rear and the inner one to the front, merging into their respective induction galleries, which then sweep upward on either side of the carburettor to the ports. From under each riser, at the lowest point, the manifold drain tubes are taken. Partly below and partly on the inside of the induction manifold is the six-port exhaust. The two are bolted together in the centre to form a large contact hot-spot, but the arrangement of the jointing flange is somewhat unusual. Instead of being in the horizontal plane, the flange is some 40 deg. from the vertical. The reason is possibly to keep the over-all width of the engine to a minimum. A large steel-asbestos heat shield is fitted on either side of the carburettor, extending almost the entire length of the induction manifold, and a cast aluminium air intake elbow fits over the carburettor inlet.

A dual downdraught carburation system is employed on the Alfa Romeo 2.5 litre sports six-cylinder engine, but details of the port arrangement are not available. It would appear that one barrel of the dual downdraught Weber carburettor feeds the front three cylinders and the other the rear three. On the Super Sports model three horizontal Weber carburettors are fitted.

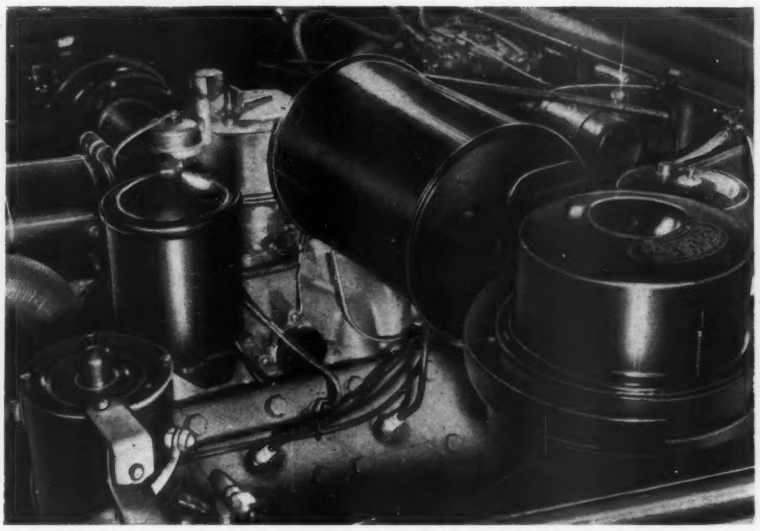
The only example exhibited of the

six-port induction system on an American car, Nash has an internal six-port tract on both the side valve "Statesman" and the o.h.v. "Ambassador" models, both engines having six cylinders. These two models also incorporate the "exhaust-pipe manifold" similar to that used on the new Ford engines. In the o.h.v. version the exhaust pipe is of molybdenum chrome and is clamped into a hemispherical channel machined in the near side of the cylinder head, orifices in the tube corresponding with the exhaust ports in the head. The pipe is closed at the rear, and after leaving the cylinder head is taken round the front of the engine and away to the rear on the off side. A rectangular channel is sunk in the top face of the cylinder block. This forms the main induction gallery, from which six port branches lead down to the individual inlet valves. A long cast cover, carrying the riser and carburettor flange, is bolted to the top of the block, so forming the roof of the induction tract, a downdraught Carter carburettor being attached thereto.

With the side valve "Statesman" model, the cylinder head itself forms the cover of the induction tract, and so carries the riser and carburettor. In addition to the heat provided by the coolant system, a hot-spot is formed under the riser by the centre exhaust port, which passes directly underneath. The same design of exhaust system is used as on the o.h.v. Ambassador model.

In the Nash-Healey, the power unit is the o.h.v. version, and here the induction manifold cover is replaced by one bearing two horizontal risers to take the two horizontal S.U. carburettors. A balance restriction is located in the middle of the tract, and each carburettor has a disc type air silencer.

On the Daimler DB-18 the six-port induction system has been retained. In this design both induction and exhaust manifolds are on the off side of the engine, the cast aluminium induction being above the six-port exhaust. Of the many varieties of the straight-rake port arrangement, this one differs from the sequence employed on the larger Daimler six-cylinder engine. On the DB-18 the two outer ports on the extreme ends of the cylinder head are the inlets. Inwards from each end there are then two exhaust ports close together in pairs. Next come two inlets in pairs, with a pair of exhaust ports in the centre. Although the cross section of the actual induction gallery is circular, the manifold is water jacketed over the whole of its length, and in external appearance the section is D shaped,



Carburettor and automatic choke on the Lincoln "Cosmopolitan".

with the curved portion facing the engine. The six-port branches which are of rectangular section, leave the main gallery at right angles to it. Two separate manifolds form part of the exhaust system, the two castings being so arranged that one manifold receives the exhaust from the front three cylinders, and so on.

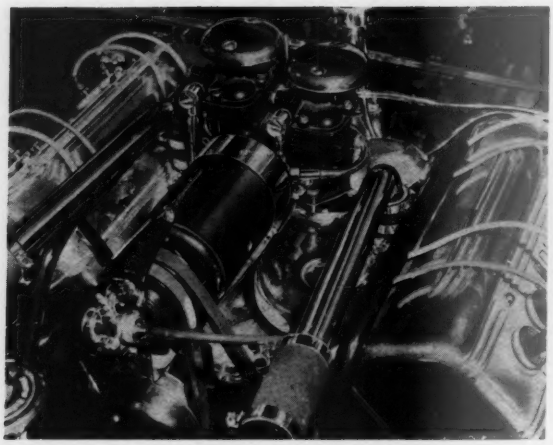
The exhaust manifolds lie close to the induction, which must pick up a good deal of radiated heat. Hot coolant is fed in and out of the induction manifold jacket from the front end, where the two pipes are attached. One comes from the water pump and the other leads to the water thermostat housing in front of the cylinder head. A single horizontal S.U. carburettor is located in the centre of the manifold, and the fuel supply is by an A.C. mechanical pump. A neat aluminium casting forms the air intake connection between the carburettor and the Blundell air silencer mounted above and across the engine.

The Sports version is somewhat different. Here, the induction manifold is much the same in general design, but arranged for a pair of horizontal S.U. carburettors instead of the one. The two carburettors are spaced between the port branches of Nos. 1 and 2 in the front, and Nos. 5 and 6 at the rear. A restriction is placed in the centre of the main induction gallery tract, so that each carburettor feeds three cylinders, with a balance channel between the two manifold galleries. As before, a single cylindrical air silencer is employed, but a large "T" shaped casting joins the intakes of the two carburettors with the air silencer. No alteration has been made to the exhaust system.

An interesting example of the compound induction system on a six-cylinder engine, the Armstrong Siddeley Eighteen remains unchanged. Employed with success on the previous Sixteen model, this system falls into the category of the so-called compound design on account of its double gallery tracts. Externally the induction manifold is a two-port one, mounted on the near side of the engine above the exhaust, the two being bolted together to provide the hot-spot. A downdraught Zenith-Stromberg carburettor, with automatic choke, bolts to the short riser, and an air silencer of the "L" type lies across the top of the engine.

Running the whole length of the cylinder head is the main induction gallery, a cored circular duct which is fed by external two-port induction manifold. From the internal gallery the six branch ports run down to the individual inlet valves. A partition carrying an orifice divides the main gallery into two parts, and the orifice performs the function of a balance. The design of the balance piece is ingenious. Forming part of a small flange that bolts over an opening in the side of the cylinder head, the dividing piece has the balance hole drilled in it. The exhaust off-take is in the centre of the exhaust manifold, below the riser, and in the wide portion of the casting, between the two, is the housing for the thermostat unit of the automatic choke. A manifold drain tube is taken from under the riser.

Among the Continental exhibits, Delage retain the six-port induction system, where the centre riser "T" is cast integral with the exhaust manifold below. The main gallery is cast in two parts in aluminium, one of which



Induction arrangement on the J.2 Allard with Ardun overhead valve conversion.

Induction manifold casting on the Studebaker V.8. Note the heavily lagged hot air pipe.

bolts on either side of the riser piece. This forms a straight-rake tract of round section, from which the six-port branches leave at right angles. A downdraught Solex carburettor supplies the mixture.

On the 3½ litre Hotchkiss, two single Stromberg downdraught carburettors are fitted, each of which feeds a three-port induction manifold of aluminium. As the exhaust manifold below is a three-port one, a hot-spot is arranged under each riser, where the induction manifold is bolted to each outer exhaust port branch.

Six-port systems are also employed on the Lagonda and Aston-Martin, but the arrangement is quite different. In both cases the induction manifold is in halves, joined at a restriction by a rubber connection. As the exhaust manifold is on the opposite side of the engine, the induction tract is water jacketed to provide heat to the mixture. Two horizontal S.U. carburettors are fitted, one of which incorporates the S.U. starting carburettor, which feeds into the balance restriction. Also with twin carburettors equipped with the S.U. starting carburettor, is the Wolseley Six-Eighty, but here the two induction manifolds are separate and cast integral with the two port exhaust manifold below.

There is no change in the Jaguar six-port induction system on the XK.120 engine fitted to the new Jaguar Mk.-VII. The induction and exhaust manifolds are on opposite sides of the engine, the induction being on the off side. Two horizontal S.U. carburettors supply mixture to a six-port manifold of cast aluminium, which is water heated over its entire length. A balance restriction is provided in the centre of the tract, into which the S.U. automatic starting carburettor delivers the starting mixture.

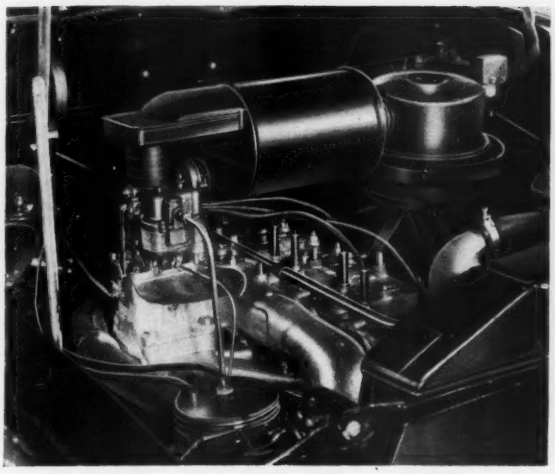
The most unconventional six-cylinder engine exhibited was the Lancia Aurelia. With its two banks of three cylinders set at 60 deg., the two three-port induction manifolds are bolted to the side of the cylinder heads, inside the vee. A dual downdraught Solex carburettor supplies the mixture, each barrel feeding an induction manifold on each bank through a twin riser casting. The riser casting is water jacketed and in circulation with the engine coolant. Also unusual is the arrangement of the carburettor throttles. Instead of the throttle valves being mounted upon a single long spindle passing through both barrels, there are two short spindles parallel with one another and arranged fore and aft. The two spindles are geared together in such a manner that the throttle valves open in opposite directions, this doubtless being a necessity owing to the induction manifold arrangement. This system of parallel throttle spindles geared together to open in opposite direction has been a feature of aircraft carburettors for over twenty years. It was also employed on the first American dual downdraught carburettor produced for automobile use some twenty years ago. Expense was doubtless the chief reason for the scheme being dropped in favour of the single spindle. There is no doubt that in certain instances much improvement can be made by employing the system.

Several of the high-performance engines have three carburettors. Among these is the Bristol two-litre 401 model. As the combustion chambers are of hemispherical form with inlet and exhaust valves at 80 deg. the three carburettors are conveniently situated between the two valve covers. Each feeding a pair of siamesed inlet valve ports, the three downdraught Solex carburettors are of the static type, without economiser or accelerating pump. A large air intake casting fits over each of the three carburettors and connects to an air silencer on the near side. Contrary to conventional practice, there is no balance channel. The exhaust system is on the off side of the engine and consists of two separate three-port manifolds, the three branches of which sweep down to the two off-take flanges.

Frazer Nash also employ a similar system, using three downdraught carburettors between the valve cover vee. Triple carburettors are also used on the A.C. engine, but here the carburettors are S.U. horizontal models, bolted to the near side of the cylinder head, so that each carburettor supplies two cylinders through siamesed ports. A small disc type air silencer is fitted to the intake of each carburettor, and a balance tube connects all three riser pieces.

Eight Cylinder Engines

The trend of American design on eight-cylinder engines appears to be moving from the well-established straight-eight to the V-eight. Studebaker exhibited their new o.h.v. V.8 in the 1951 Land Cruiser, a model previously powered by the six-cylinder engine. Following current practice, the induction manifold is a single casting embodying the induction tracts which run over and under one another, together with an exhaust heated hot-spot. A dual downdraught Stromberg carburettor of the AAV type is employed, the throttle spindle being at right angles to the crankshaft. While details of the induction ducting were not available, it would appear that the off side throttle barrel feeds cylinders 1 and 4 on the near side and cylinders 2 and 3 on the off side,



Hudson straight-eight induction manifold above exhaust showing hot-spot valve thermostat.

Rochester side-entry downdraught carburettor on the Oldsmobile "Rocket" engine.

and vice versa. An extra port branch on either side, between the induction branches, align with corresponding ports in the cylinder heads. These maintain circulation with the exhaust manifolds on the outside of each bank, through a jacket under the two risers, so providing a hot-spot under the riser "T" junction. The conventional hot air automatic choke is employed, the thermostat system being in a chamber at the end of the strangler spindle. In this instance the stove from which the hot air is taken is placed on the exhaust manifold on the near side bank. This means that the tube connecting the carburettor thermostat box with the stove is about 18in. long, and to avoid loss of heat, the pipe is heavily lagged to an overall thickness of nearly an inch. A large oil-bath air cleaner is mounted on the off side, and connected to the carburettor intake by a smoothly curved metal pipe, fabricated by two sheet steel pressings welded together. The mechanical fuel pump is located above the vee in front of the manifold casting, and carries a glass-bowl filter.

Exhibited for the first time last year, the Cadillac V.8 was designed for exceptionally high compression ratios. Here again the induction tracts are in a single complicated casting, and details of the ducting were not available. A dual Carter carburettor supplies the mixture, one throttle barrel feeding two cylinders on each bank, the tracts passing over and under one another within the casting. Like the Studebaker, an extra port branch on each side of the casting, between the induction ports, supplies the hot-spot jacket under the twin riser with exhaust gases from ports in the heads. Not only is there a glass-bowl filter on the fuel mechanical pump, on the off-front of the engine, but there is an additional bowl filter attached to the carburettor fuel inlet. Here the stove for the hot air automatic choke is on the exhaust pipe at the rear of the off side bank, so that the length of the pipe is longer even than that of the Studebaker.

The pipe is lagged over most of its length. This matter of conservation of heat is always something of a problem with this form of automatic choke, and it is interesting to observe that on the Lincoln V.8 Cosmopolitan, the carburettor thermostat box has been taken off the carburettor and attached to the induction manifold casting, which is of the usual dual carburettor pattern, located in the vee. A link rod connects the thermostat element with the strangler spindle. The side entry downdraught Holley carburettor is retained, to the air entry of which is attached a cylindrical air silencer. In addition, an oil-bath air cleaner is also fitted, the air passing through the cleaner first.

Yet another V.8 engine designed for high compression ratios is the Oldsmobile Rocket. This o.h.v. engine follows conventional practice in the layout of the single induction casting containing the eight-port tracts, fed by a dual downdraught carburettor. Like the previous examples, exhaust gas is fed across and round the dual riser "T" junction through two separate exhaust port branches incorporated in the induction casting, one on either side. A thermostatically controlled flap valve in the near side exhaust manifold is so arranged that when cold, exhaust gas is directed back through the near side cylinder head, round the hot-spot under the risers, through the off side cylinder head and out into the off side exhaust manifold. When the engine is hot the flap valve permits the exhaust from the near side bank to pass direct into its exhaust pipe, which is underneath the engine to the off side. A feature in the design of the heat valve is such that the thermostat spring, bob-weight and stop spring are so arranged that their separate reactions are towards the same direction on one end of the valve spindle. This has the effect of forcing one end of the spindle upwards and the other downwards, so eliminating rattle, a condition sometimes present in this kind of valve when wear occurs. Carburation is by a dual downdraught Rochester carburettor, a product of the General Motors concern.

Like the Holley, the carburettor is of the side-entry, downdraught pattern which requires less bonnet head-room than the orthodox straight - through downdraught, as the air intake orifice is at the side instead of at the top. A hot-air automatic choke is built into the carburettor in the usual manner, and the hot air pipe is short and is not lagged, being taken down into the exhaust branch port of the hot-spot. A long cylindrical air silencer with a central feed fits direct over the horizontal carburettor entry, so that it lies across the top of the engine. The mechanical fuel pump, complete with glass-bowl filter, is low down on the off side front of the engine. It is claimed that this position results in the fuel keeping at a lower temperature when running.

Allard continue to use the Ford V.8 engine, but in the J-2 model the engine is equipped with the Ardun o.h.v. conversion unit. This makes a very neat assembly, leaving plenty of space for the pair of aluminium four-port induction manifolds, one to each bank, which lie in the vee. Each fed by a single downdraught Solex carburettor, the manifolds are of rectangular section, the galleries turning in gener-

ous curves to the end ports. Arranged with the throttle spindles parallel with the crankshaft, the accelerator control operates on the off side carburettor throttle, and a connecting link rod connects this with the near side carburettor spindle. Air silencers are not fitted, but a dished cowl over each carburettor protects the intake.

Alone among the straight - eight cylinder engines, the Daimler carburation system is unusual on a two-four-two type of engine. In this instance a straight-rake eight-port manifold is employed, fed by a pair of downdraught S.U. carburettors. Arranged on the off side, the induction manifold is water-heated over the whole of its length by a coolant jacket, the actual tract being of round section, although like the Daimler 2½ litre engine, the outer form of the casting is D shaped. Of square section, the eight port branches are disposed in four pairs, with the two downdraught S.U. carburettors being placed midway between the outer and inner pair at each end. The port branches rise some three inches from gallery to cylinder head port. A balance restriction in the middle of the tracts serves to separate the two galleries. Each carburettor has its own Blundell air silencer, and a separate manifold drain tube is taken from the manifold under each carburettor. Located underneath the aluminium induction manifold is the eight-port exhaust system, which takes the form of two separate four-port manifolds, with separate off-takes. Always a worthwhile item, a reinforced asbestos heat shield is placed under each carburettor to protect them from exhaust heat. Fuel supply is by the conventional mechanical fuel pump.

No change has been made in the carburation system of the Buick straight-eight, where the dual downdraught Stromberg carburettor supplies a twin-gallery tract of the usual kind. Here the outer throttle barrel feeds cylinders 1 and 2, and 7 and 8 through the long outer gallery, while the inner barrel supplies cylinders 3 and 4 and 5 and 6. The manifold is thus a four-port one, the valve ports being siamesed. On the Buick much attention has been given to keeping the main induction galleries truly horizontal. The engine has a considerable transmission tilt when installed in the chassis, and while the front port branch is flat, the other steps down progressively towards the rear, where the rear port branch drops some four inches to the cylinder head port.

Hudson employ the same type of ducting system on the straight-eight engine, although the form of the casting is different. The dual downdraught Carter carburettor feeds two separate galleries, but the galleries run direct from the riser T to the ports, instead of the galleries turning into branches. Thermostatically controlled hot-spots are employed, and a coil spring is attached to the flap valve spindle to prevent rattling.

CLUTCHES AND GEAR BOXES

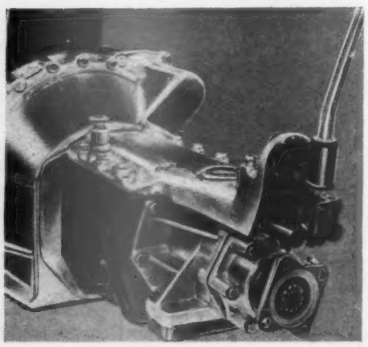
High Degree of Standardization on British Cars

THE advance of the hydraulic torque - converter transmissions bids fair to eliminate the pedal-operated friction clutch on American vehicles. This will eventually cause a major modification in pedal layout, an anticipation of which is to be found on the Studebaker Commander. Here the brake pedal is made wider than normal so that it can be operated conveniently by the left foot. This should make for road safety, as careful tests show that there is a saving of about 0.15 seconds in application delay when one foot is already in position on the brake pedal and has not to be transferred from the accelerator position.

Those American models, and they are still many, that continue to fit a clutch all use single-disc units of the Borg and Beck or similar type. A noticeable point is the universal employment of sleeve-mounted ball thrust bearings for withdrawal instead of the carbon rings so common on English cars. Ball thrusts are employed on the new Dagenham-produced Ford cars, the makers of which call particular attention to the fact. One of the deciding factors is the probability of private car components being used for van and taxi purposes. The carbon ring is barely up to such duty without more frequent attention than the clutch itself requires.

Continental practice favours the ball bearing and the Lancia models continue the firm's previous practice of direct withdrawal without intermediate levers. Except for the fact that this arrangement imposes considerable end load on the crankshaft the arrangement seems to have much to recommend it. In spite of the necessity for a larger withdrawal bearing the cost, in large-scale production, should be less, as the additional leverage can easily be provided in the withdrawal mechanism, especially if this is of the cross-lever type and not the cross-shaft layout rapidly becoming obsolete. Although great care is taken by clutch makers to eliminate friction in the intermediate levers, clutch operation should be slightly more consistent if they were eliminated.

The ample oscillation permitted to the power unit by modern rubber mountings has, in general, involved some stiffer control of fore-and-aft movement if clutch engagement is not to be interfered with by propeller-shaft spline thrust. Fairly hard rubber end-location pads are, for example, used on the Austin chassis while others use a mechanical radius link. The manufacturers of rubber mountings have devoted considerable attention to the matter of giving stiffness in one direction combined with a freer movement in the other. An example of this is to be found in the Metalastik mountings fitted to the 14 h.p. Lanchester and the new Ford "Consul" and "Zephyr" models. Here the front mounting consists of two circular pads on each side of the engine some way back from the front, inclined to give an elevated oscillation point. They consist of two steel discs with rubber bonded between them with the addition of a steel interleaf. This arrangement, as is well-known, stiffens the rubber considerably in compression without affecting its flexibility in shear.



Jaguar XK 120 gearbox.

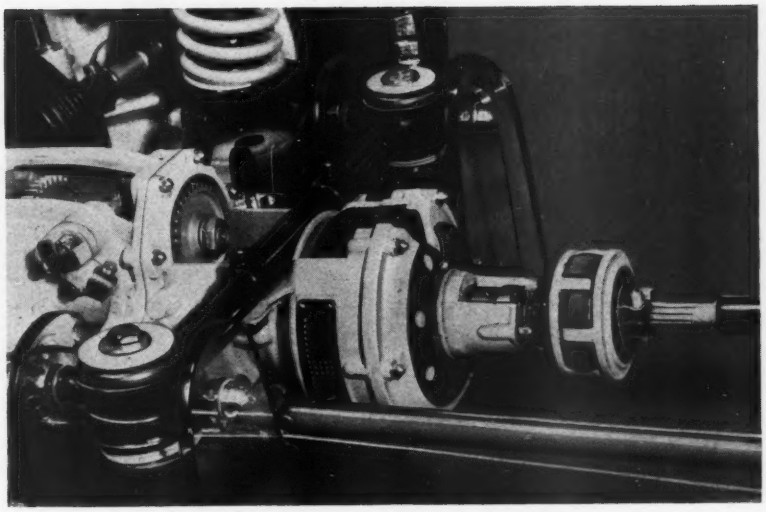
At the back of the gearbox the power unit is supported on a Metaxentric bush. This consists of an inner steel sleeve placed eccentrically within a much larger outer one, the space between being filled with bonded rubber except at the bottom, where the inner sleeve is close to the outer one. Here, for an arc of about 90 deg., there is a gap in the rubber. The

effect is to give considerable flexibility in a vertical direction, combined with greater stiffness to resist fore and aft motion. A similar arrangement is to be found on the Metalastik Metacone slotted type mounting. Here the rubber is cored out on each side of the conical mounting, giving considerable flexibility laterally, but greater stiffness in the fore and aft direction.

On the new Ford "Consul" and "Zephyr" cars the ball-bearing withdrawal race is operated by a lateral lever, the projecting end of which is thrust by a small hydraulic cylinder connected to a master cylinder linked to the clutch pedal. The flexible pipe takes power unit movements and further makes it possible to employ pendant pedals for both clutch and brake. These are hung from the scuttle pressing and the two master cylinders lie side by side, fed from a common reservoir. Pedal slots and wells are thus eliminated, and the pedals themselves are simple stampings without any stem needing additional stiffness in the levers to provide lateral stability. The inverted arc described by the pedal plate is also more in conformity with the movement of the leg of a driver.

Given a clutch-withdrawal race completely enclosed and lubricated from the gearbox, such as that fitted on the Rover chassis, it would seem to us an obvious step to maintain a light load always on the withdrawal bearing. The recuperation hole in the clutch master cylinder would thus automatically take up any movement due to wear and so eliminate all need for pedal adjustment.

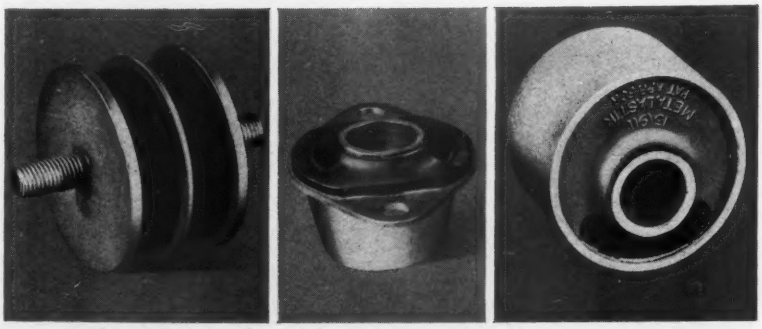
Probably the most interesting clutch arrangement was that on the Lancia "Aurelia" chassis. Here the gearbox is built in a unit with the frame-mounted differential box and includes the single-disc clutch also. This has a disc diameter of $6\frac{5}{8}$ in. and has its own flywheel assembly, with an outside diameter of about $7\frac{3}{8}$in., secured by setscrews to a short stub-shaft carried on two ball bearings. Connection to the 6-cylinder 1,754 c.c. engine (which gives 56 b.h.p. at 4,000 r.p.m.) is by a solid propeller shaft having rubber cushion joints at each end. These consist of a rubber ring about $4\frac{1}{2}$in. in diameter and 1in. thick with eight moulded radial slots engaged alternately by four vanes on two diecastings attached to the driving and driven members.



Clutch and rubber universal joint on the Lancia "Aurelia".

The clutch flywheel would appear to have a moment of inertia about 20 per cent. of that of the engine rotating masses and the rubber couplings are flexible enough to keep the oscillation frequency of the clutch flywheel well below any normal engine crankshaft frequencies. The clutch seems rather small for the power it has to transmit, but ground clearance sets a strict limit, especially as the clutch shaft is below the driving pinion shaft in the differential assembly. Ventilation holes, provided with overlapping screens, are arranged in the front face of the clutch housing, which has louvres, rearwardly directed, on its outer circumference. The pressure plate is loaded by a number of double compression springs and is withdrawn direct by a ball thrust bearing supplied with oil from the gearbox. Especial care has been taken in the provision of oil throwers to keep lubricant from the clutch disc.

On cars fitted with the Wilson gearbox, the fluid flywheel takes the place of the clutch. On the new 14 h.p. Lanchester the engine has been carefully tuned to give the maximum torque at about 1,000 r.p.m. which is the stalling speed of the fluid flywheel. This point is of considerable importance in obtaining a quick getaway without the temptation to slip the gear-bands of the Wilson box. On the American torque-converter equipped cars the same effort is made to secure an engine torque as high as possible at fairly low speeds. The stalling speed of the average torque converter is about 1,500 r.p.m. and maximum engine torque is obtained at not more than 2,000 r.p.m.

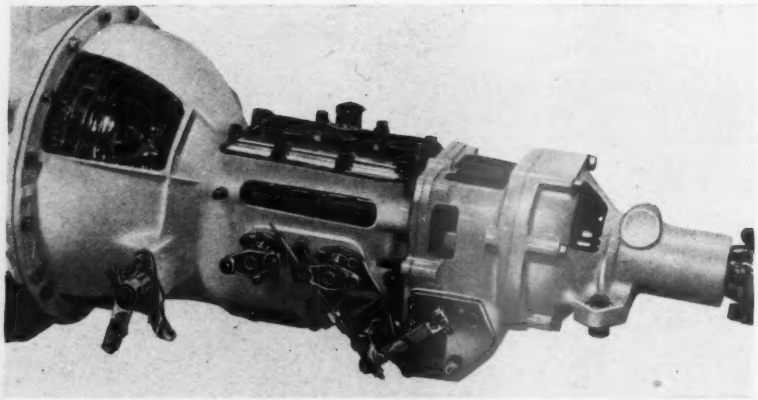


Metalastik bonded rubber mountings. Left—Interleaved circular mounting. Centre—Metacone slotted type mounting. Right—Metaxentric bush.

Gearboxes

While four speeds are practically standard on English cars, nevertheless three speeds only are provided on some recent and highly popular designs. The Vauxhall models and the Standard "Vanguard" and Triumph "Mayflower" are examples. In the case of the first two the power-weight ratio is good. On the "Mayflower" the engine gives 38 h.p. resulting in moderate power-weight ratio only, a deciding factor probably being the use of the same three-speed box as fitted to the "Vanguard", which is in large scale production.

The two new Ford Dagenham-built models, the "Consul" and the "Zephyr", also have three speeds only. Power-weight ratio is good with b.h.p. figures of 47 and 68 respectively for kerb weights of 2,435 and 2,591 lb. Second speed ratio is 1.65 to 1, making



Standard "Vanguard" gearbox with De Normanville overdrive.

it a useful gear for acceleration to fairly high speeds.

Baulked synchromesh of the Warner type is almost universal and, in conjunction with the steering-column lever appears to give satisfaction to most motorists. At the same time it must be admitted that synchronising cones are on the small side and rapid changes especially downward, are not always so easy as might be wished. Lack of stiffness and robustness of some of last year's column controls has been the subject of criticism and some firms emphasise that improvements have been made.

There is little doubt that the sporting type of driver is disappointed in column control and baulked synchromesh. For this type of vehicle, constant-load synchromesh and a central lever are much preferable. Some firms, such as Lagonda and Aston-Martin, offer alternative gear lever positions. In the case of these particular cars this is much simpler owing to the fitting of a D.B.S. gearbox which can be converted from central to column control (right or left hand) by merely interchanging the top cover and striking-fork assembly.

When using column control the striking rods extend forward into the bell-housing where a hanging finger strikes the gears by lever and rod connection to the column spindle, selection being by rod and bell-cranks which slide the selector shaft sideways. The change-over can, if necessary, be made without taking the gearbox out of the chassis, a good feature in cars sold to customers with very individual preferences.

In some cases the change over to left hand drive hardly appears to have been envisaged in the original design, the Humber Hawk, for example, requiring the addition of a massive cross-shaft passing under the bell-housing to transmit the striking motion from a left-hand steering box.

One rather poor feature is the exposed collar, engaged by a round-ended fork, that constitutes part of the selecting connection on many cars. While the loads are admittedly light, dust has free access and parts of this kind often wear more quickly if they are lubricated.

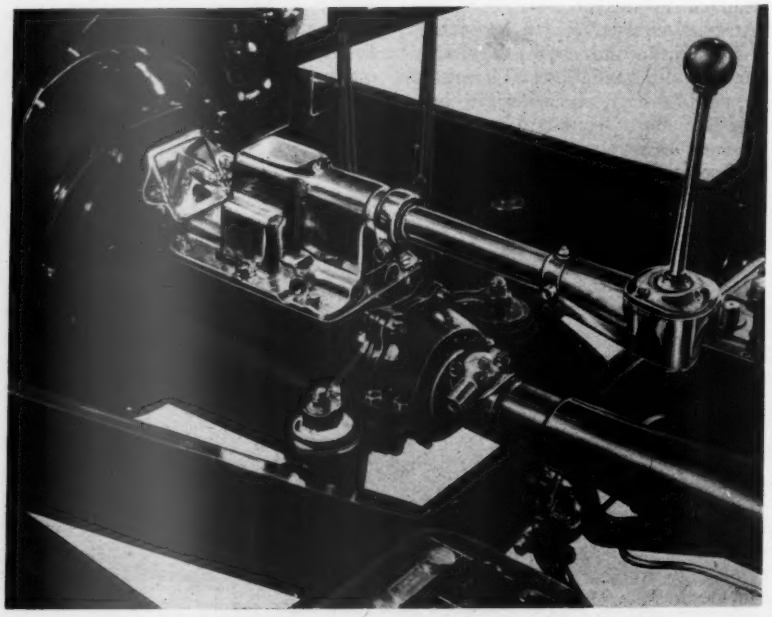
On the Lancia "Aurelia" the gearbox is at the back of the car and the gears are operated by a sliding and rotating tube with universal joints at the gearbox end connecting it to the striking shaft, in a manner frequently to be seen on commercial vehicles. The spindle on the column carries at its lower end a worm, meshing with a worm wheel having a lever rod-jointed to a laterally-extending lever on the tube below.

This provides a greatly improved form of the collar and bell-crank mechanism, criticised earlier in these notes. The worm, of course, acts as a series of collars, its helical form being incidental as the cheapest way of generating collars and a quadrant to mesh with them. This excellently made mechanism however really merits some form of cover so that thick grease could be used without attracting all the local grit.

Regarding gearboxes, such a degree of standardisation has been reached that there is little of interest to record. Three examples show considerable originality and one of these is the Bristol. As applied to an expensive car, setting a high standard, it is well worth study where first cost is not the main and only consideration.

Split on the vertical centre line, the aluminium case carries the shafts on six bearings, the intermediate ones being between third and second speed wheels. Synchronising is by constant-load cones of exceptionally large diameter, in fact as large as a running clearance from the layshaft will allow. Rapid synchronisation can thus be attained without excessive pressure. Exceptionally rapid changes can be effected by overriding the loading balls. It is also possible to double-declutch without the risk of overdoing it and finding the change baulked on the other side of the clearance.

First speed is by a dog clutch without synchronisation engaging a hub on which the first speed driven wheel runs on a free-wheel. A shockless change into first speed can thus be made under any conditions, while driving at low speed on first is free from any jerky motion on releasing the accelerator. Reverse necessarily entails an additional train and this is just behind the rear bearing and housed in the



Allard gearbox and torque stay ball joint.

gearbox rear extension. A sliding calliper lock is provided and the spring-plunger notches in the neutral position are shallower than in the engaged positions making the passage across the gate more delicate while giving ample holding power for the clutches.

On the Fiat 1400 the four-speed gearbox is arranged with the third speed wheels against the rear wall of the box and the second speed wheels behind it, giving direct support to both gears. First speed is provided by a wheel sliding on the sleeve which acts as the top and third speed clutch. The arrangement might be described as a Vauxhall gearbox with an extra speed added behind it, this train of gears being conveniently housed at small expense in the rear extension which is in any case necessary. The four-speed gearbox of the Lancia "Aurelia" is combined with the differential housing, and the drive is indirect. The driving shaft lies below the driven one, which is integral with the spiral bevel pinion. Top speed is a slight overdrive and the gears for it and third speed, together with the sliding wheel for first speed, are inside the gearbox. The second speed gear train is in front of the box, housed in a casting forming the rear part of the enclosure for the clutch.

The higher three speeds are synchronised and all the cones are on the driving shaft, all gears being fast on the driven shaft. None of the gear-wheels, except the small first speed pinion, form part of the spinning mass of the driving shaft, and the clutch disc, as mentioned elsewhere is distinctly small at $6\frac{3}{8}$in. diameter. The masses involved in a gear change are therefore exceptionally light, and moreover, since all the synchronising cones are on the driving shaft, all have equal and unit leverage when in action. In contradiction to nearly all other gearboxes, second speed synchronises as quickly as any other, which should make for consistent and easy gear-changing. The only objection is that when the box is in top gear the second-speed train idles at rather a high tooth speed.

David Brown remote control gearbox showing position for column control cross shafts.

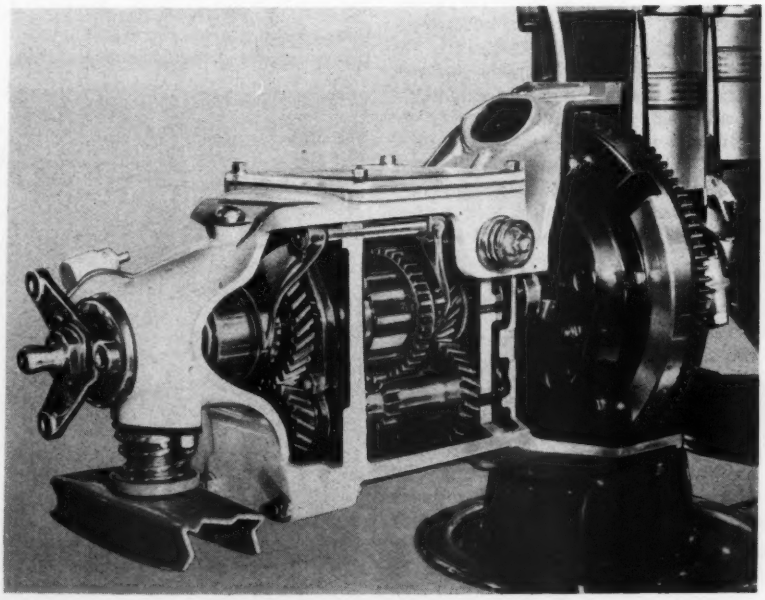
Overdrives applied to standard three-speed gearboxes are offered by most American firms, these generally being of the type which requires closing of the throttle and deceleration of the engine to get into overdrive. The De Normanville overdrive, mentioned in last year's Show report, is now fitted as standard to one of the Triumph models and as an extra to the Vanguard car. This epicyclic mechanism is engaged by hydraulically-operated cone clutches, with the addition of a free-wheel that picks up direct drive as overdrive is disengaged. Compared with the American automatic overdrives the De Normanville arrangement has the advantage that overdrive, being frictionally operated, can be engaged with the engine pulling on full throttle. A quick change is thus possible, with no interruption of torque, while much of the kinetic energy of the engine flywheel is available to assist acceleration during the change.

The latest models give a 28 per cent. overdrive, instead of the 22 per cent. previously offered. The ball control valve is connected to the change-speed lever on the steering column in such a way that a slight lifting of the knob when in top gear engages the overdrive, direct being regained by a touch down to the normal position. This overdrive does not of course give an intermediate ratio on the lower gears.

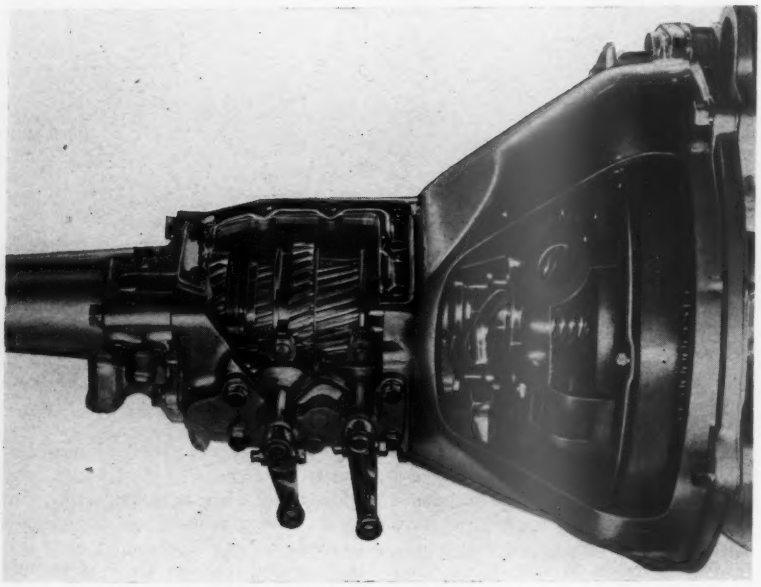
Of the epicyclic gearboxes the Cotal electromagnetically controlled four-speed box was shown by Delage and Delahaye while Wilson boxes with fluid flywheels are standard on all Daimler and Lanchester models. Armstrong Siddeley offer Wilson gearboxes as an alternative, a centrifugal friction clutch replacing the fluid flywheel in this instance.

While the Wilson gearbox remains unaltered in principle, slight modifications have been made in the gearing to permit of crown-shaving the wheels and annuli, giving greater silence.

The Hobbs four-speed semi-automatic gear, described in connection with the Commercial Vehicle Show, was also exhibited at Earls Court in a size suitable for a private car. In this case third speed is provided by braking an annulus instead of by holding the planet carrier. This permits much closer ratios to be provided, these being in one example 1 to 1, 1.44 to 1, 2.28 to 1, 3.80 to 1 and



Gearbox and clutch of Fiat 1400.



Vauxhall clutch and three-speed gearbox.

5.29 for reverse. This transmission requires no clutch pedal, the hydraulically operated clutches in the flywheel being released by centrifugally operated valves as the engine speed drops.

In the American automobile industry a remarkable change is taking place. Every maker showing at Earl's Court offers at least one model with some form of automatic transmission, generally of the torque-converter type. So popular have these become that it appears that in a short time the normal gearbox will be extinct on American cars. It must not be forgotten however that all the torque converter systems rely for reasonably economical operation on high power-weight ratios. Even so, fuel consumption is always higher than for a similar car with orthodox transmission. The time is not yet ripe for applying the American developments to the special circumstances of the British.

Four different torque-converter automatic transmissions were exhibited, one of these being shown in two different forms. Common features of all are hydraulic torque converters giving an increase of torque in the stalled position of about 2.2 to 1. All are alike in having two alternative ratios, under manual control, the "drive" position being intended for normal conditions and the "low" position for ascending steep gradients, running for prolonged periods at low speed in traffic and also to obtain additional engine braking on long steep down grades.

The change from "low" to "drive" ratio and vice-versa can in all cases be made at full throttle and generally at any speed below 40 m.p.h. While a certain amount of discretion is still desirable, great care and ingenuity has been devoted to making the change of ratio as shockless as possible. Much of the complication of the hydraulic control gear is due to these "fool-proofing" precautions. Controls are always hydraulic and all systems have two oil pumps, one driven by the engine and one by the transmission. Both these pumps are running all the time, but the larger one, that driven by the engine, merely idles when the car attains normal speed, the smaller pump driven off the output end of the transmission being big enough to take over the work. The power absorbed by these pumps varies from about 1 to 2 h.p. according to conditions.

Among the duties devolving on these pumps is the maintenance of enough pressure in the torque converter to prevent cavitation. In all cases except the Studebaker and Ford Mercury, the oil that is circulated through the converter also passes through an external cooler jacketed with water from the radiator outlet. Where the cooler is fitted, the radiator capacity is increased by about 10 to 15 per cent. In the case of the Studebaker and Ford the converter casing is ribbed and acts as a fan to draw air over itself and keep the oil at a temperature below about 240 deg. Fahrenheit as a maximum.

Change of ratio or ratios and reverse are always obtained by epicyclic gearing with disc clutches for direct drive and fabric-lined band brakes for the lower gears. The control lever operates hydraulic valves and has a neutral position in addition to a parking position in which the transmission is in neutral but, in addition, the output shaft is locked by a pawl engaging a toothed wheel. This relieves the driver of the responsibility of applying the handbrake and requires less effort and thought. It also avoids the risk of driving with the hand brake on.

Those unfamilier with these mechanisms will find that the description of the Buick "Special" in the *Automobile Engineer* for May 1950 embodies a good deal of useful information.

In the General Motors torque converters as fitted to Buick and Chevrolet cars there is considerable refinement in the torque converter itself. This has two reaction members mounted on free wheel clutches, while the pump section is also sub-divided, one part being connected to the other by a free wheel clutch. The arrangement gives a better accommodation of vane angle to the flow conditions existing at any particular ratio of conversion and in particular raises the efficiency of the converter in the region where change over from conversion, to fluid flywheel action, is imminent. A maximum efficiency of something like 95 per cent. is attained, with 90 per cent. when the converter is giving a 50 per cent. increase of torque.

In both these cars the converter is always in action and is associated for low range and reverse with an epicyclic reduction gear having a drop of about 1.8 to 1 under the control of a hand lever. In the Buick scheme described in *The Automobile Engineer* for May 1950 there is a special anchor piston on the low gear band which facilitates the change from high to low ratio by modifying the oil pressures to avoid a lock-up, owing to both gears being engaged at once. It is understood that it has been found possible to omit this complicated mechanism, the tran-

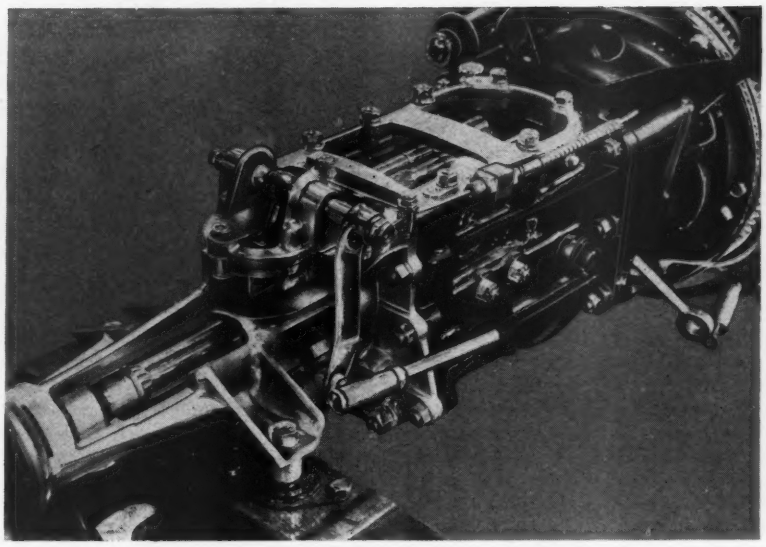
Column controlled David Brown gearbox on the Lagonda.

sition from high to low being effectively controlled by regulating orifices.

The Chevrolet converter is identical with the Buick in its proportions, but being a low price large production job, it is entirely made from steel pressings instead of from plaster mould aluminium alloy castings. The vanes are about 30/1,000in. thick and are pressed in a multiple operation with narrow flanges that accurately fit the inside of the pressings forming the pump, stator and turbine casings. Location is by spot welding completed by copper brazing. Another special feature of the Chevrolet converter is the addition of what may be regarded as an over-run fluid flywheel in the vacant torus space of the converter. This is of peculiar design with radial vanes rather like a Sirocco ventilating fan, those in the pump member being rather smaller radius than those in the turbine element.

The effect is, that when the engine is driving and the pump runs faster than the turbine, the fluid coupling is almost ineffective on account of the difference in radius of the vanes. On the over-run however, when the turbine is turning faster than the pump, the difference in radius added to the difference in speed gives a rapid vortex flow and a much greater degree of coupling. This largely overcomes one of the objections to the torque converter namely, that on releasing the accelerator pedal there is a considerable interval before the engine starts to act as a brake, the feeling being described as that of a "cushioned backlash" in the transmission. It must also be remembered too, that while the torque converter when driving gives a torque multiplication up to about 2 to 1, on the over-run this multiplication is entirely absent since the stator vanes are free-wheeling.

The Packard "Ultramatic" transmission is similar in principle to the General Motors mechanism, but the torque converter is without both these refinements. In practice this is more than compensated for by the fact that the transmission has a single disc clutch running in the oil with the converter, which locks the converter solid at over 50 miles per hour at full throttle and down to much lower speeds on part throttle. Since much of the work of the average high-power car can easily be done on direct drive, the somewhat lower efficiency of the simple torque converter used on the Packard is of no importance. It is out of action most of the time, yet is instantly available at low speeds by depressing the accelerator pedal fully. Another feature of the Packard transmission is that the locking clutch is engaged down to a speed of 12 miles an hour when the accelerator pedal is released. The engine can therefore act effectively as a brake without any "backlash" feeling.



"SM.1500" gearbox showing enclosed slip joint in extension.

On the Studebaker "Commander" chassis the epicyclic gearbox gives three speeds instead of two. Top gear in this case is engaged by a single disc clutch acting in a similar fashion to that on the Packard to cut out the converter altogether. On release of this clutch the converter drives into a reduction of 1.4 to 1, instead of direct on to the output shaft. The effect is therefore to give a step change of 1.4 to 1 in the "drive" ratio and a greater available torque increase, being the product of converter and epicyclic gear ratios, without the necessity of changing to the "low" ratio. There are arguments for and against this arrangement, but in a hilly district it should give a rather better economy than the standard converter. On a steep gradient the torque multiplication provided by the epicyclic gear would reduce the demand on the torque converter itself, which would be running most of the time as a fluid flywheel.

The low ratio on the Studebaker gives a bigger drop than those provided by Packard or General Motors and the direct drive clutch cannot be engaged when in low ratio. Adequate engine braking is, however, provided by the increased overall ratio.

On the Mercury chassis the simple converter is used in conjunction with a three-speed epicyclic transmission. There is in this case no friction clutch in the converter, but top gear is direct in the transmission, with the converter available to increase the torque. At a given point depending on speed and throttle opening, the mechanism changes down automatically into the intermediate ratio of the epicyclic box, while further reduction is available by manually engaging "low" ratio. One of the advantages claimed for this as compared with the Studebaker arrangement is that a higher top gear ratio can be used, since the converter is always in service and available to take any added load.

There are many ingenious detail refinements on the various systems, among which might be mentioned that on the Studebaker. A hydraulic cylinder is arranged to prevent accidental engagement of the parking lock until the vehicle has come to rest and the oil pressure has dropped off. Among the problems incidental to torque converters is the liability to creep on the level when stopped at a traffic light, unless the brake is applied. On the Studebaker the foot brake, after having been applied to bring the vehicle to rest, is held engaged by a ball valve until the accelerator pedal is slightly depressed for the restart. This provision will probably become superfluous, since most drivers will grow accustomed to using the left foot for the brake and the right for the accelerator pedal. Studebaker themselves have foreshadowed this by making the brake pedal much wider so that part of it comes in a convenient position for the left foot. Restarting on a steep gradient will thereby be greatly facilitated and a greater rapidity of brake application should make for road safety. There may however be a good many minor collisions in traffic, owing to a following car with normal transfer from accelerator pedal to brake being unable to stop as quickly as a

torque converter vehicle in front.

There were two other types of automatic transmission on American cars, one, the Hydromatic, introduced by General Motors many years ago, being used by several. This consists of a four-speed epicyclic gearbox automatically controlled, according to speed and throttle position, by hydraulic mechanism, a fluid flywheel being provided to cushion the drive and for starting from rest.

Chrysler exhibited cars fitted with an automatic transmission incorporating a fluid flywheel in series with the friction clutch and a four-speed synchromesh gearbox automatically controlled by hydraulic mechanism. A feature of this box is a freewheel clutch in one of the layshaft wheels which enables the change from top to third gear to be made without racing the engine. It has also enabled the makers to get four speeds out of three pairs of wheels by employing the third speed wheels as an alternative constant mesh train.

REAR AXLES AND REAR SUSPENSION

Hypoid Bevels Firmly Established. Improvements in Lateral Stiffness

THE hypoid bevel is practically universal, though the Rover Company still continue the use of spiral bevels, as do the Riley cars. An Italian newcomer, the Lancia "Aurelia" also uses spiral bevels. This however, could hardly have been avoided, since the gearbox is combined with the differential assembly with its driving shaft below the pinion shaft and the use of a hypoid bevel would have reduced the ground clearance under the gearbox to an unpractical figure. Worm gearing is employed on a well designed axle by Rubery Owen for the Austin taxi chassis. In this the worm is carried on a central casting completed by two bolted-on side flanges to which the swaged side tubes are attached by butt welding.

Banjo axles are used on the new Dagenham-built Ford "Consul" and "Zephyr" cars, this being a complete change of policy on the part of the English Ford Company, paralleling similar action in the United States. On the other hand, the whole of the Nuffield group, with the exception of the Riley, now use split axle cases, this practice being followed in the two M.G. chassis, which use components from the production line of the other cars.

A banjo axle generally implies location of the differential shafts and wheels at the outer ends, but on the Buick chassis a highly ingenious arrangement is employed which when seen on a sectional drawing looks like a draughtsman's mistake. Here the flanged axle shafts run on parallel roller bearings at their outer ends, these providing no end location at all. The inner ends of the shafts are assembled into the splines of the differential wheels, split washers are inserted into grooves in their ends and the shafts are then pulled out until these washers seat in recesses in the differential wheels. Assembly of the two-pinion differential, cross pin, wheels and distance piece through the rear cover of the axle then prevents the shafts from drifting inwards again. In these days of wide distribution of excellent service manuals there appears to be no objection to this scheme, which certainly saves a good deal of money at the outer end. In the absence of specific instructions however, a garage mechanic asked to dismantle the axle would be somewhat mystified.

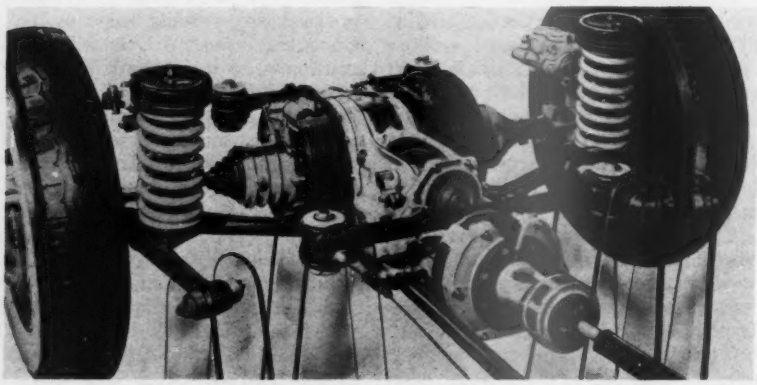
There seems to be no fixed policy in axle design. For example, the Nuffield organization years ago made a three-quarter floating axle, in which the wheel does not become detached through fracture of a differential shaft, a basic feature of their design. All the new Nuffield vehicles have semi-floating axles. The Ford Company who formerly used semi-floating axles with the differential shafts located at their inner ends have now gone over to three-quarter banjo floating axles.

The Salisbury axle is increasingly employed and is used on the 14 h.p. Lanchester and Morgan.

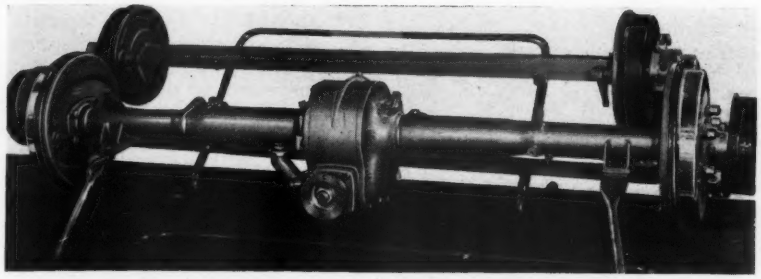
On this type of axle a one-piece casing serves as differential mounting and load carrying member, the differential bearings being half buried in the enclosing metal. This makes a very stiff assembly and is not subject to the lateral spread of the bearings common with many banjo axles having differential assemblies with plummer-blocks.

The needle roller universal joint appears to be standard for propeller shafts, and there is no evidence, such as was apparent at the Commercial Vehicle Show, of attempts to reduce the over-hang of the joints by designs dispensing with flanges. This state of affairs will probably not long continue. The propeller shaft of the Fiat 1400 is interesting. Of the divided type, it is carried about the centre by a ball bearing assembly housed in a thick rubber ring. The rear shaft has ordinary Spicer needle roller bearing joints. The front shaft has a rubber block coupling at the gearbox end, the driven spider of which is journalled in a bush in a fairly large propeller shaft tube. The rear end of the tube is carried by the intermediate bearing. The drive is taken by a small torsion shaft emerging at the rear end with splines for the Spicer flange. The front end is splined to the rear spider of the gearbox joint. Two split bushes are inserted in the tube at intermediate points to steady the torsion shaft, which is so small in diameter that it would otherwise whip. The arrangement would appear to give a very considerable cushioning effect and its combination with a rubber block joint, which has a more or less harmonic deflection curve, will presumably eliminate oscillations.

Experiments made in Germany during the War, chiefly on 3-ton lorries, showed that the engine mass is in a continual state of angular oscillation



Lancia "Aurelia" gearbox, differential and rear suspension assembly.



Worm-driven Rubery Owen for the Austin taxi.

at a fairly low period, tuned by the spring of the differential shafts. It is not quite clear whether this Fiat torsion bar would give much more angular movement than the differential shafts already provide, but being in a different place it may be of more value.

There were several cars at the Show with differential assemblies mounted on the frame and road wheel drive by short universally jointed shafts. On the Lagonda and Allard chassis standard Spicer universal joints with slip splines are employed. On the new Lancia "Aurelia" the inner joints are of the "pot" type having two radiused blocks sliding in cast iron guides and fitted with needle roller bearings to take the cross pin. A detachable splined coupling connects the inner half of the shaft to the outer portion, which passes right through the hub to a needle roller bearing universal joint outside it, thus a fairly long shaft is provided without the necessity of crowding the inner assembly, the short side shafts of which carrying the brake drums are given an additional support by ball bearings as well as fitting into the splined differential side wheels. The hub bearings are of interesting construction, consisting of two very narrow opposed taper roller bearings forming one assembly, this arrangement being necessary to provide as large and as short a hole as possible through the wheel-carrying arm to allow for the articulation of the universal shaft.

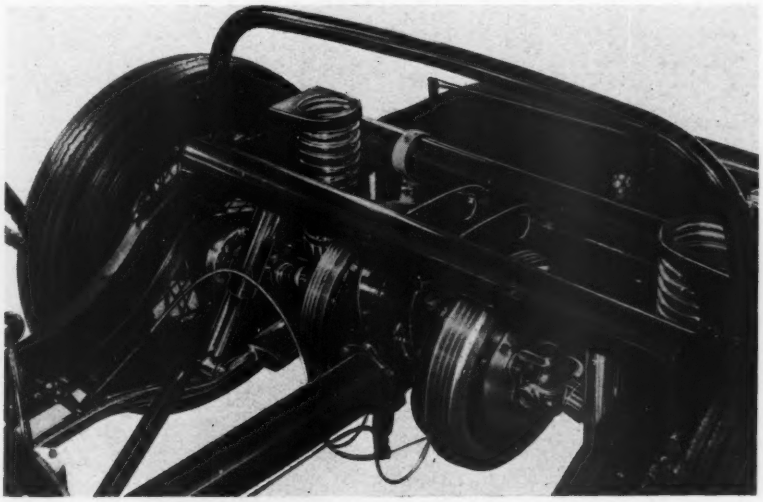
Most cars have Hotchkiss drive, and rubber spring bushes of the Silentbloc type at the front end and of the Harris flexing type in the shackles are almost standard. Associated with these features, which are common American practice, is the setting of the telescopic dampers at an angle across the car. This is claimed, and quite rightly, to prevent side sway, but by this must be understood the side movement otherwise permitted by the rubber spring shackles, etc., and not the rolling of the car on its springs. This is, as a matter of fact, not quite so well controlled by this arrangement of dampers as by vertical location.

On the new 14 h.p. Lanchester, metal bushes are used for the rear springs and shackles, these being automatically lubricated by a Luvax thermal lubricator. This consists of a small oil pot clipped to the exhaust pipe fed by a check valve from a reservoir above and connected to the distributor pipe-work by a heavily loaded spring check valve. The expansion of the oil in the pot as the exhaust pipe warms up causes a small quantity to pass the check valve and travel to the various points, each of which has an appropriate restricter. When the engine cools down the chamber draws a small quantity of oil from the supply tank ready for the next cycle.

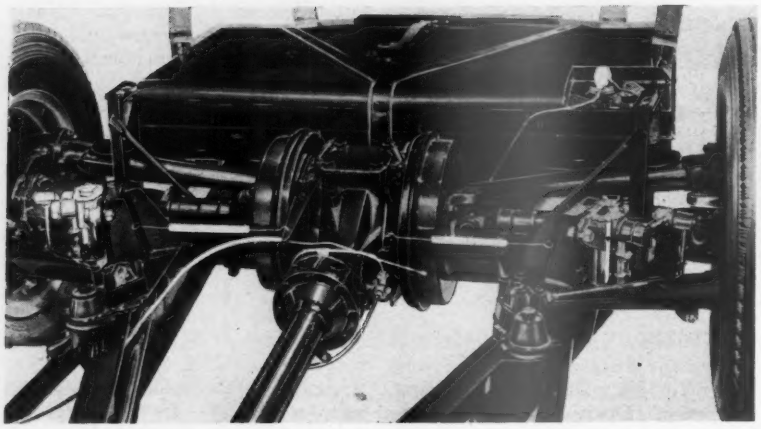
Where diagonally mounted shock absorbers are not employed on Hotchkiss axles having rubber bushed spring shackles, a Panhard rod giving more rigid lateral location of the axle is often employed. Such an arrangement is standard on the Rover car and is now fitted on the Sunbeam-Talbot. Both these rods have end joints of the Silentbloc type, while the Panhard rod on the torsion bar sprung Jowett back axle, has rubber washers as joint members. Certain criticism may be made regarding the employment of this type of joint for a rod which, in the case of the Jowett, is fairly short and works through an appreciable angle. The rubber may tend in time to become fatigued and allow more side play than is desirable, whereas the more enclosed Silentbloc bush should have a long life.

The M.G. designers continue the practice of fitting thin round rubber pads under the tips of the rear spring leaves, each pad being retained in place by a teat fitting a hole drilled in the leaf. On the Humber "Hawk", Hillman "Minx" and Sunbeam-Talbot cars the spring leaves have shallow recesses into which are fitted discs of fairly hard rubber which take the load and, as in the case of the M.G. arrangement, transfer the normal sliding action of steel on steel into a noiseless shearing action of the rubber. It is understood that both these schemes have proved satisfactory in practice and will probably be widely employed. It seems more effective than any system of interleaving which does not involve complete enclosure of the spring to keep it free from mud and dust. On the larger Humber cars the spring leaves are totally enclosed in plastic covers and one or two other makers follow this practice.

The new Fiat 1400 chassis has an interesting suspension for its banjo type rear axle. The load is carried by two coil springs of large diameter. The torque and driving thrust is taken by laminated spring steel assemblies of about the length of the front halves of a normal semi-elliptic spring. These, however, consist of a master leaf and upper and lower leaves only of thick material, held together by clips. Besides their function as radius and yielding torque rods, they also act as an anti-rolling mechanism, being stiffer in



Allard final drive and De Dion rear suspension.



Lagonda final drive assembly and rear suspension.

a vertical direction than a leaf spring of ordinary proportions. There is in addition, behind the axle, a spring steel bar journalled at its ends in rubber bushes on the frame and bent forwards at its centre where it is attached to the back axle in a substantial rubber bush bearing. This rod, which is slightly bent to avoid dead rigidity, acts to assist in locating the axle laterally and also modifies the spring rate as the bar is stretched and straightened out slightly by the opposing arc movement as it swings above and below centre line.

On the Aston Martin the beam rear axle is also carried on coil springs, located by parallel motion links and a cross rod in a similar fashion to a Jowett axle, though in the case of the Jowett two of the links form part of the torsion bar suspension.

Torque tube construction is rare but is used, for example, on the Buick chassis in conjunction with coil springs and a Panhard rod on rubber bushes for lateral location. The Riley cars also continue the employment of a central torque tube with two diagonal stays. On the new English Ford models the previous standard torque tube practice is discontinued.

The Bristol chassis has a remarkable suspension of its beam rear axle by two longitudinal torsion bars coupled to cranks connected by links to the axle arms. The arrangement is such that the axle ends move in an absolutely vertical plane and no interference of the steering characteristics of the car by angular movement of the back axle is possible. Lateral location of the axle is by a wishbone hinging on a frame cross member and ball jointed to the upper part of the axle casing. This link, together with the two suspension arms, also resists driving and braking torque. The roll centre is high, being at the ball joint between the wishbone and the axle casing.

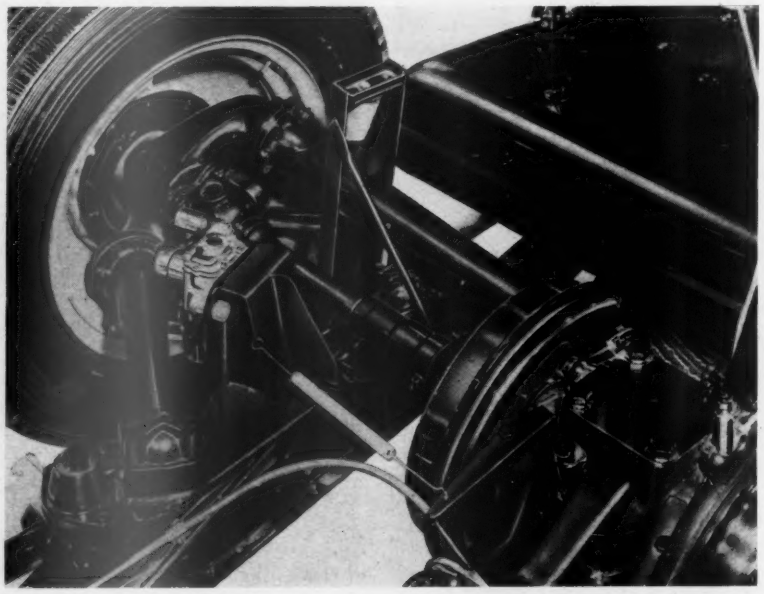
The Allard chassis has a De Dion type axle located by two radius rods converging on a central ball joint, there being two coil springs with lateral location by a Panhard rod.

The Lagonda rear wheels are independently sprung, the hub carrying members being attached to two arms that are jointed by rubber bushed ball joints to points in front and behind the wheel centre line. The line joining the two ball joints runs diagonally so that the motion of the wheels partakes somewhat of swing axle and of trailing link movement.

A somewhat similar geometry, though with a rather different layout is employed on the new Lancia "Aurelia" chassis. Here both the arms are in front of the axle centre line and their ends work in rubber bushes set at a dihedral angle. The movement partakes more of the trailing-than swing-axle. On the Lagonda, the load is carried by torsion bars running along a diagonal frame bracing and connected to the hub carrying members by levers and ball jointed links. In the Lancia "Aurelia" the load is taken direct by coil springs bearing on the two arms that form a wishbone.

In both these cases movement of the wheels above or below centre gives a "toe in" effect as seen from the front, thus contributing an "under-steer" action to the handling of the car. The same applies to suspensions of the Volkswagen type such as that on the larger Alfa Romeo, where a ball jointed swing axle is located by radius rods going forward on each side. In the rear-engined Renault chassis the swing axles are constrained to move in a plane at right angles to the chassis centre line by needle roller bearing locations on the inner ends of the arms.

Quite a number of cars have anti-roll bars at the rear, but some strange variations in practice are to be found. One of the Rootes group cars, for instance, has an anti-roll bar at the back consisting, ingeniously, of a piece of square bar clamped in split square sockets integral with the damper arms. The Sunbeam-Talbot chassis, however, has the usual round spring steel anti-roll bar at the front linked to the wishbone arms. There are certain difficulties with American patents in this country and this may have determined the action of some firms on whose chassis the anti-rolling bar is intended more to give general stiffness to the vehicle as a whole than to ensure "under steering" action at high speed.



Layout of Lagonda independent rear suspension.

FRONT SUSPENSION AND STEERING

Much Interesting Detail but no Major Developments

WITH the fitting of coil-spring and wishbone front suspension to the Sunbeam-Talbot "90" the A.C. car remains the only English representative of the beam front axle on semi-elliptic springs. In France Renault offer a 17.9 h.p. car without I.F.S. but this is intended for estate and taxi work rather than high-speed road travel. The suspension of the Allard chassis is another exception to the general rule, being of the divided beam-axle type with coil springs to carry the load and side radius rods to locate the axle ends.

At first sight this suspension would seem to be very unsuitable for high-speed competition work, in which this make has been very successful, for not only does the design give excessive tyre scrub, but the gyroscopic effects of one wheel rising over an obstacle are just as bad as on a beam axle. Although one wheel only is concerned in this case the angular movement is doubled by the halving of the axle.

The secret doubtless lies in the fact that the suspension is very stiff and that the large diagonal dampers, acting at nearly full wheel track, exercise such a powerful control that gyroscopic movements are damped out before they become serious. The design is none the less, quite unsuited to modern private car conditions, where far more flexible suspension and absence of fierce damper settings is essential.

Uncommon, though suffering from no appreciable geometrical inaccuracy, are the vertically-sliding wheel mountings of the Morgan and the Lancia "Aurelia", while the new Ford "Consul" and "Zephyr" cars have front suspensions that are really a composite of the vertically sliding and wishbone arrangements.

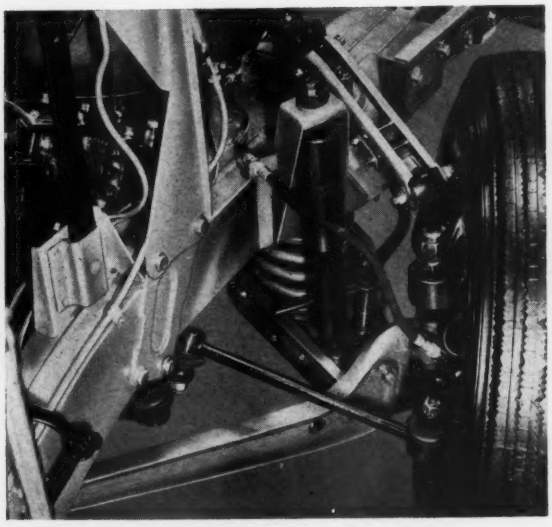
On the Morgan chassis the spindles on which the swivels slide are now inclined inwards at 2 deg. each side and also given a rearward angle of the same amount. Positive lubrication is now provided by pipes from the engine connected through a pedal-operated valve intended to be momentarily opened by the driver every 100 miles or so. The layout incorporates large direct-connected telescopic dampers, more flexible front springs, and plain thrust washers between the coil springs and the steering swivels. These are isolated by flexible spring steel radius plates from the winding and unwinding action of the coils, which might otherwise have unpleasant reactions on the steering.

On the Lancia "Aurelia", a stamped "I" section beam bolted to the main frame carries at its outer ends, vertical tubes projecting above and below it and on the outsides of these slide and rotate tubular bushings attached to the steering swivels. The double-acting damper is within the vertical tube, connected to the swivel by a piston rod secured to the capped upper end of the upper bushing. The coil springs are outside the lower guides and are enclosed by light telescopic shields. They bear upon light pattern ball thrust bearings. Positive lubrication is provided for the upper guiding surfaces, while the lower guide, which has a blind bottom end can be relied upon to retain sufficient lubricant.

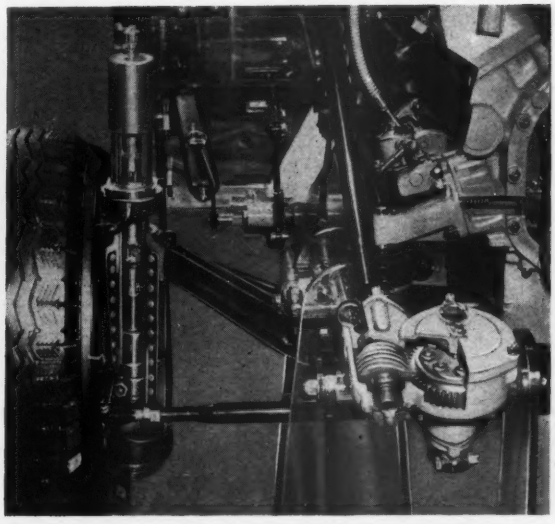
The bump movement is 70mm. and the rebound 50mm., the guide tube being set at a swivel pin angle of slightly over one degree, the offset at ground contact being 84mm. The front wheel has a camber of about 2 degrees and the tyre has a close running clearance from the upper guide bushing. The steering arms are about 6in. long and are connected by a track rod in front. The steering gear has a vertical drop-arm spindle, the gearing consisting of a multi-start worm meshing with a straight-toothed spur gear. The box is in front of the axle beam and is connected to the steering arm on the opposite side by a long drag-link. A point of interest is the employment of rubber bushes of the Silentbloc type for the track- and steering drag-link joints. The rubber is on the thick side and the bushes are fairly short.

On the new Ford "Consul" and "Zephyr" cars the steering swivels are attached to the casings of long, vertical, telescopic dampers. Towards the upper ends of these are attached flanges on which the coil springs bear. Their upper ends seat on pressings attached to the absorber piston-rods which transmit the load to the car structure by opposed taper roller bearings. These are mounted in rubber bushings and seated in pressings bolted to pressed brackets on the front wing valances, which are an integral part of the monococque body.

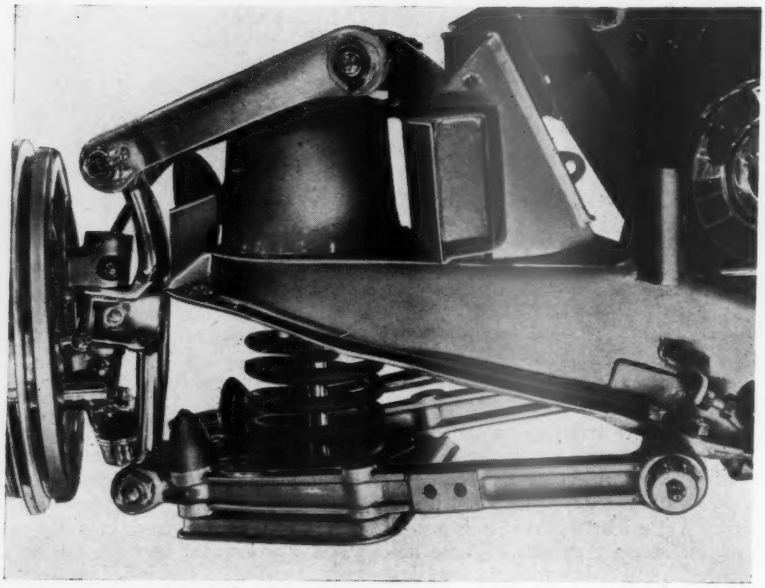
At the lower end, the assembly is



Front suspension of the Rover "75".



Lancia "Aurelia" front suspension and steering



Front suspension assembly of the Sunbeam-Talbot.

located by ball joints in the swivels attached to the outer ends of laterally extending radius rods. Fore-and-aft location of the ends of these is provided by the front-mounted anti-rolling bar. The rearwardly-extending arms of the bar pass through and are connected to the radius rods by opposed Metalastik bonded cone bushes. The anti-rolling bar is a vital part of the front wheel location and is attached to the frame by two rubber bushes in brackets. These are firmly clipped to the arms of round-section bar in such a position that the axis of the bushes coincide with the cross-axis of the anti-rolling bar. The steering arms are behind and are coupled by short rods to an intermediate cross-rod carried at one end by the steering box drop arm and at the other by a slave arm.

There are one or two queries raised in the layout. There will for example, owing to up and down movement of the swivels and radius-rods, be considerable twisting of the rods about their inner attachments to the frame. The arrangement would seem to demand a ball joint. Satisfactory functioning is however attained by the employment of a special Metalastik H.D. bonded bush. The rubber sleeve is short and thick, is bonded to both inner and outer tubes, and pre-loaded after assembly by compression of the outer tube.

The ball joints in the swivels move in an arc, while the upper end of the assembly moves in a straight line passing through the roller-bearings in their rubber bushings. The wheel scrub is therefore quite considerable. It is actually somewhat more than the arcuate movement of the radius arms implies, totalling some 2in. in track between bump and rebound. There is some change in wheel camber with suspension movement but this is about normal and agrees in direction and amount with that found to be satisfactory in wishbone suspensions. In these cases it is obtained by the difference in length of upper and lower wishbones since the radius arm is so set that it works almost entirely below centre line.

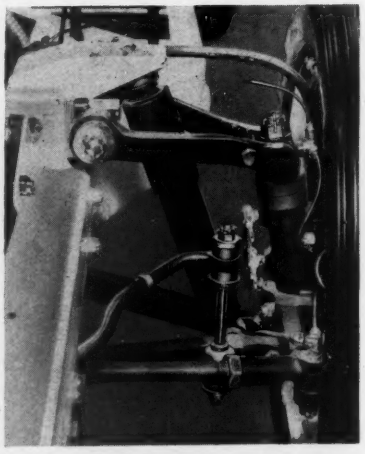
Rigidity of location of the swivels under braking and lateral loads should be good, on account of the wide spacing of the upper and lower location points. These loads cause some bending stresses on the damper spindle and side loads on its gland bush. The damper body is however much longer than the stroke requires, and the piston never comes near to the gland bush. Excessive leverages are therefore avoided.

Of those few cases still employing the transverse leaf spring the Humber Snipe is an example. This year the redesigned spring gives a lower rate and is 5in. wide, double its previous width, the master leaf being reduced to 2in. at the eye. In the past many transverse leaf spring suspensions had a bad name on account of rapid development of end play in the eye joints. On the Bristol chassis this point is dealt with by totally enclosing the spring and eye joints in gaiters packed with grease.

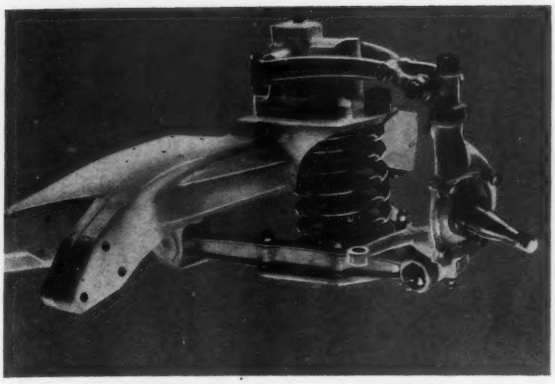
The great majority of front suspensions are of the wishbone type and there is now a large degree of standardisation in geometrical proportions. There is a tendency to replace the piston damper acting as upper wishbone by a telescopic type placed inside the coil spring. On the new Wolseley models the previous damper has been replaced by a wishbone with eccentric adjustment for camber with two telescopic dampers located side-by-side above it. The general purpose behind such changes is doubtless the attainment of more consistent and lasting damper action by reducing working pressures and increasing the volume of fluid displaced.

We have on previous occasions drawn attention to the extent to which English and American designers have "agreed to differ" on the question of inner wishbone bearings. The marked difference still exists, every American car at Earl's Court having hardened steel screwed bushes at these points and every English maker, with the exception of the Rootes Group, using rubber in some form or other. This is the more remarkable in that American designers pioneered the fitting of rubber bushes to rear spring eyes and shackles and every American car shown was so equipped. An interesting feature of the screwed spindles of the lower wishbones on the Hillman Minx, Humber Hawk and Sunbeam-Talbot cars is that they are made of hexagon bar. One of the flats is held against the face of the cross-member by "U" bolts fitting in grooves turned in the spindle. While this simplifies manufacture as compared with the stampings used in America, the location is not as rigid as that provided by bolts in bolt holes.

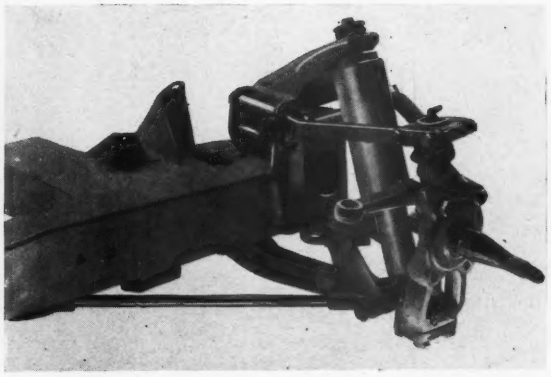
Of the rubber bearings used by English designers the Metalastik bonded cone is very popular. It is



Front suspension of the new Lanchester Fourteen.



Austin front suspension with Metalastik bonded cone wishbone bearings.



Jaguar independent front suspension assembly embodying torsion bar.

employed on all Austin cars and in particular on fast cars such as the Mark VII Jaguar, the 2½-litre Riley, the Lagonda, etc. While more expensive than the simple Harris type parallel bush it has two advantages. Owing to the coned assembly it is possible to secure uniform preload while using much thinner rubber. The opposed cones and the thin preformed flanges contribute to make the whole assembly much more rigid in both axial and radial directions.

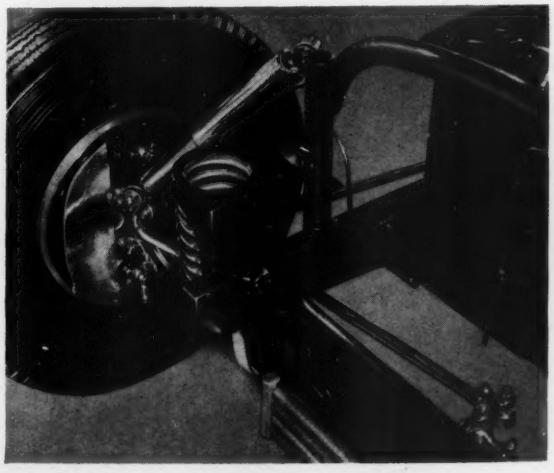
It can also be argued that a coned component is more likely to be correctly assembled by the average mechanic and that the presence of a little grease is not so serious. It will not upset correct preloading as with a parallel bush in which the rubber has to be forced along a parallel annulus and may prefer to flow outwards at the flange if this is greasy.

The Andre Silentbloc Co. showed their flangeless taper bush which seems to go far to combine the low cost of the Harris type with some of the advantages of the cone. Here a rubber bush, moulded taper on the outside only, is forced over a parallel tubular sleeve till its thin end is flush while the thick end overhangs. In assembly, the taper portion fits a similar taper bore in the wishbone arm, which thus comes to a full bearing immediately. A through bolt or spindle draws together two washers on the ends of two opposed bushes, which butt at the centre, metal to metal, while the overhanging rubber at the thick ends is forced up as flanges until the washers bear, metal to metal, on the outer ends of the tubular sleeves.

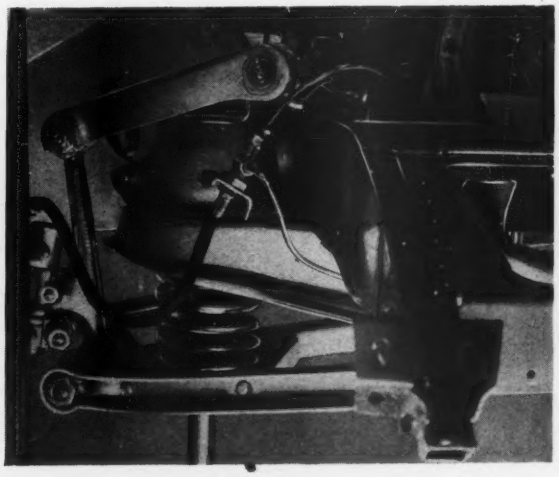
While one of the advantages of rubber is its cushioning effect, this can sometimes be overdone in front wheel suspensions. There are certain vehicles on which the use of more or less unconfined rubber in the suspension linkage apparently gives rise to pronounced front brake "shudder" on account of excessive flexibility.

Wishbone-type suspension in conjunction with torsion bars is employed on several cars, including the Citroen, on which vehicle the scheme originated. The 14 h.p. car produced by the Lanchester Co. is the latest convert to the system. In this design, Metalastik bonded cone bushes support the upper and lower wishbones, with metal-to-metal bearings at the outer ends. These are positively lubricated from a Luvax thermal lubricator. Developed in collaboration with Messrs. Salter, the torsion bars are of the laminated type. Approximately rectangular in cross-section the torsion pack consists of five thick spring-steel plates. No special preparation of the edges is necessary. In proportions, they are almost identical with the bars on the original Volkswagen. One of the reasons for their employment on the Lanchester is that they are conveniently short and the anchorage can be made on one of the frame bracing members. An equivalent round bar would have been so much longer as to require the addition of a special cross-member to take the anchorage torque.

Except for this point, which applies to this particular chassis only, it is not claimed that any reduction in weight is made. The system is in fact slightly heavier than the orthodox round bar. There has been some claim that the

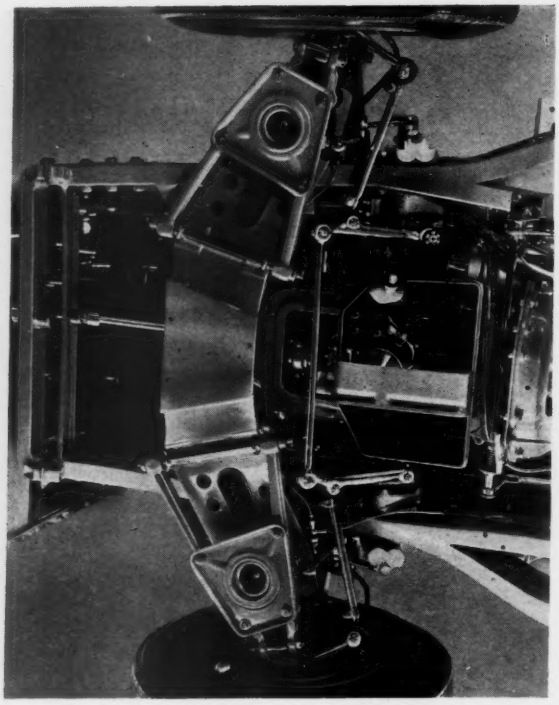


Allard divided axle front suspension.



Hillman "Minx" front suspension.

Lagonda independent front suspension



Humber "Hawk" suspension and steering layout.

system has an advantage in additional damping by interleaf friction. It has to be borne in mind however, that this variable and inconsistent frictional damping is one of the serious defects of the leaf spring and one of the troubles that the torsion bar is intended to eliminate.

While several of the wishbone-suspended cars had rack and pinion steering, this as a rule is confined to the smaller models. The great majority are steered by rod connection to a drop-arm on a steering box. Most of these are of the cam and peg, screw and nut or recirculating ball types supplied by the specialist makers such as Cam Gear, Adamant Engineering Co. and Burman and Sons.

The layout of the rodwork evidenced differences in theoretical geometry often corresponding to the price-category of the particular model. There is however, in general very little to choose between the four main systems. This is especially so if the steering arms are of generous length and the final rods run parallel, under normal load, to the actual or inferred wishbone link.

The simplest and most economical layout is that, for example, on the Hillman "Minx". Briefly this is the long and short rod system, each one going direct from the drop arm to the steering swivel. One theoretical objection is that the short rod is often too short and that the long one is too long. These errors more or less cancel out, as far as "toe-in" is concerned for a simultaneous movement of both wheels, which is the most common form of large displacement in a car running on a good road. Another theoretical disadvantage is that on lock, the drop arm balls rise and fall, destroying the parallelism of the rodwork. The importance of this drawback too, can be much exaggerated.

An ingenious modification of this layout is employed on the Buick cars. Here the location of the drop arm would make the short rod very much too short. While therefore the long rod goes direct from the drop arm to its swivel the short rod goes to a ball joint part way along the long rod and can thus be of reasonable length. The effect of rise and fall of the drop arm on the short rod, the one that matters most, is also reduced.

On the Humber "Hawk", the scheme is better. There are two short rods of very nearly correct length, one going to the drop arm and the other to a slave arm on the other side, coupled up by an intermediate rod. The geometry is nearly perfect except as regards the rise and fall of drop-arm and slave arm balls on lock.

For almost absolute accuracy, for what it is worth, there is the new Sunbeam-Talbot "90" layout in which the two rods are exactly parallel and agree with the lower wishbones. They are connected to a central slave lever moving in a horizontal plane and introducing no rise and fall error on lock. There will be trifling errors from the rise and fall of the steering-arm balls on account of the king-pin inclinations.

Front suspensions by trailing link are employed on the Healey and Aston-Martin cars. The Aston-Martin is unusual in having the coil spring seating direct on the steering swivel assembly. Both embody the obvious step of having the anti-rolling bars fitted to the lower swinging arms.

There are wide divergences in the detail work of anti-rolling bars on front suspensions. Some designers merely place the end of a mutilated steel bar into a wad of rubber in the wishbone. Others provide immaculate rubber bushed ball joints on links. The less desirable rubber washer form of joint is still employed in some instances.

A presumably successful crudity is that on the Kaiser "Henry J". Here a slightly bent steel bar is merely clamped at its ends to the two front wishbone arms. This provides the restraint, without any bearings on the frame, the anti-rolling effect being secured by the bending of the bar and not by twisting it. It is rather wasteful of spring steel but since the bar also takes a part of the normal wheel load, some of its weight should be credited to the main suspension layout.